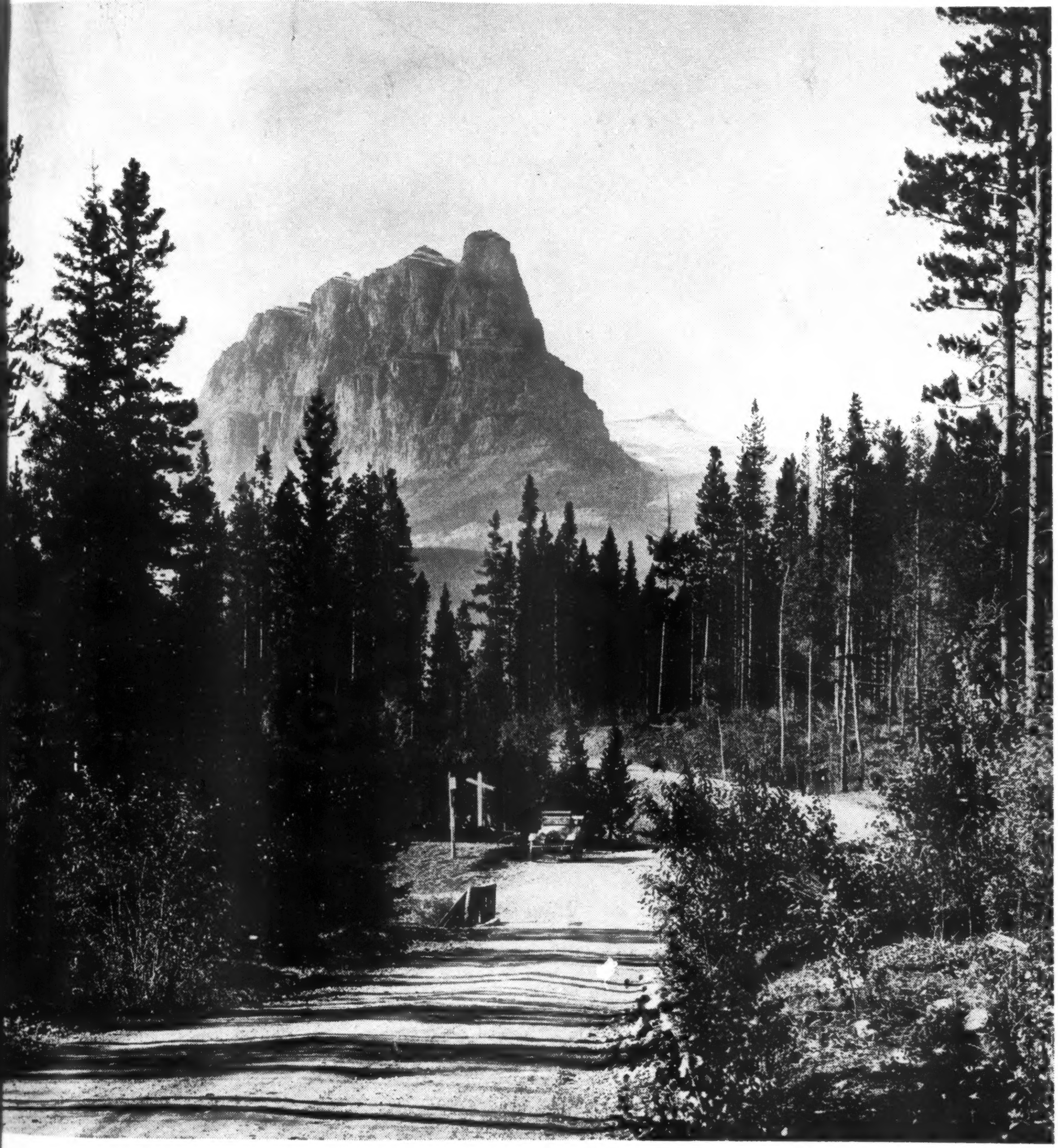
Compressed Air Magazine

MAY 1946



MT. EISENHOWER, CANADIAN PEAK

Dominant height in Banff National Park named in honor of U. S. General.

Photo, courtesy National Parks Bureau, Ottawa

VOLUME 51 • NUMBER 5

NEW YORK • LONDON

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TUNE IN THE TEXACO STAR THEATRE EVERY SUNDAY NIGHT STARRING JAMES MELTON WITH HIS GUEST, ED WYNN—CBS

ON THE COVER

AS A TOKEN of their respect for General of the Army Dwight D. Eisenhower, Chief of Staff of the United States Army, the Canadians have named for him one of the outstanding peaks in their Rockies. It is the former Castle Mountain, the predominating feature of the topography between Banff and Lake Louise. General Eisenhower was notified of the honor while he was in Canada last January. The name was officially adopted by the Geographic Board of Canada and the notification was made in a memorandum from Prime Minister McKenzie King.

Mount Eisenhower has an altitude of only 9390 feet, but its isolated position gives it eminence and distinction not attained by some of its loftier neighbors. It commands 11 miles of the valley of the Bow River, and has been described as a "gigantic castellated rampart erected by Titans." It was seen and noted by early explorers but did not attract much attention until the Palliser Expedition of 1857, when Sir James Hector gave it the name of Castle Mountain because of its resemblance to the ruin of some age-old fortress.

Following the construction of the Canadian Pacific Railway through the valley at the foot of the peak in 1883-84, lead and copper ores were discovered in the area and there was a great influx of prospectors and miners. A settlement called Silver City sprang up at its base, and in 1887 it numbered 1500 inhabitants. The ores proved to be rich but not extensive, and once this was realized the population gradually moved on and within a few years not a trace of the town remained. The rocks that compose the mountain are of sedimentary origin. The base and lower slopes are chiefly quartzites and the upper reaches are limestone and shale.

According to an Indian legend, the peak is the home of Chinook, the small blind daughter of the Southwest Wind. When warm winter breezes come from the heights and quickly melt the prairie snows they say that Chinook is searching for her lost parent, whom she will never find because of her blindness. Disappointed and saddened, she returns to her mountain home and winter again closes down on the world.

•

APPEAL FOR FOOD

EMERGENCY food-collection depots will be established all over the United States on May 12. Both food in tin cans and money with which to buy food will be accepted on behalf of UNRRA and will be used for famine relief in war-stricken countries. The foodstuffs needed are: processed milk, meat, fish, peanut butter, baby foods, baked beans, stews, soups, honey, fruits, juices, and vegetables.

Compressed Air Magazine

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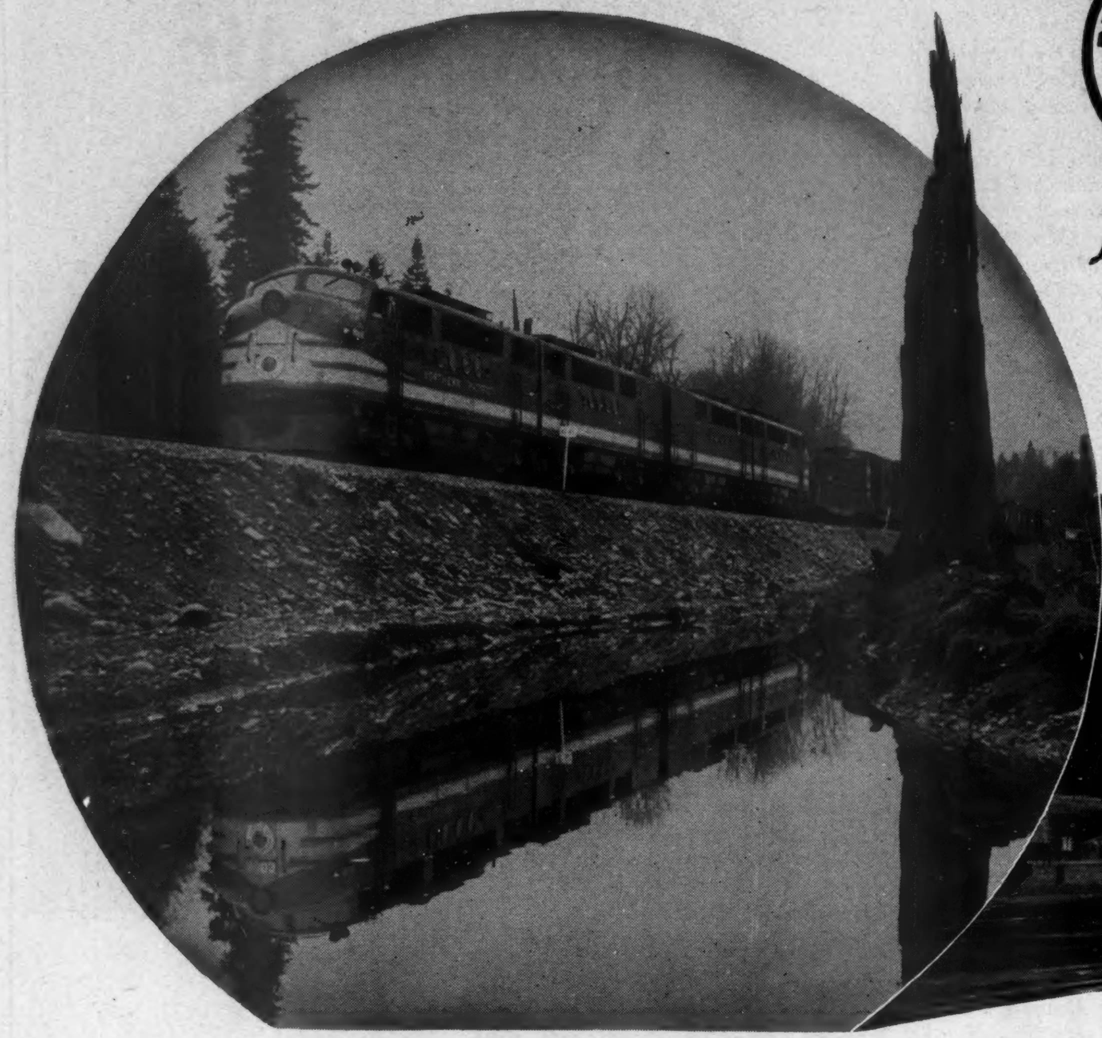
The Northern Pacific

Lawrence A. Luther



The first railroad to follow the trail of Lewis and Clark into the Northwest

HAD centuries of erosion not whittled steadily away at the treasure of the Mother Lode, scattering tons of raw gold through California's rivers, and had not John Marshall discovered some of it in digging Sutter's millrace, the Northern Pacific Railroad doubtless would have been built before the Union Pacific-Central Pacific line. The Northern Pacific route, following closely the trail of the governmentally sponsored explorers Lewis and Clark, was the first to be thoroughly surveyed and publicized as a transcontinental railroad, and the first to be advocated as such in Congress.

Discovery of the yellow metal lent glamour and impetus to California's development, which have never quite declined, and becoming the terminus of the first railway to the Pacific was an extra dividend on that boom. But demand for a rail line into the Northwest was so insistent that fanfare over driving the golden spike at Promontory Point in Utah to join the Union Pacific and the

ALONG THE N. P. LINE

One of the eleven 5400-hp. diesel locomotives placed in service in recent years is shown at the extreme left pulling a freight train on the western slope of the Cascade Range near Maywood, Wash. In the center is a dual-purpose steam locomotive drawing a fast freight into the yards at Paradise, Mont. Self-styled the "Yellowstone Park Line," the Northern Pacific provides access to the popular national playground in Wyoming. In that area is found some of America's finest scenery, as exemplified by the view below of Jackson Lake and the Teton Mountains. At Livingston, Mont., the railroad has built the modern shops pictured at the left. At the bottom of the opposite page is shown a track gang cutting-in approach track to a new tunnel through the Bozeman Mountains in Montana.

Central Pacific had not subsided before Federal legislators were again listening to numerous advocates of the Northern Pacific project. The Congress had passed a bill authorizing construction of the Union Pacific-Central Pacific in 1862, and President Lincoln signed a bill to build the Northern Pacific two years later.

The vast area extending from the Great Lakes to Puget Sound then had no highways worthy of the name, and the industrial paralysis incident to a lack of transport seems to have made the comparatively small and inefficient iron horse of that era a more romantic object in the public mind than aircraft ever became in the dawning age of flight. Men everywhere were thinking and dreaming railroad. A prospectus, complete with route map, published in 1868 at Covent Garden by an Englishman, Alfred Waddington, epitomized this ferment. That promoter warned his countrymen that they must not take the general affluence enjoyed in the Victorian era for granted, and advocated a transcontinental line through Canada as a means of averting for Britain the threatened "loss of her trade with the East and commercial supremacy." Under the heading, "Difficulty of constructing railroads through unsettled country," Waddington pointed out that the first American line was already in the Black Hills and said, "Such difficulties do not deter the Americans. With them, on the contrary (as they have learned from experience) settlement and the institutions of civilization not only follow, but may be said actually to accompany the railroad."

Building of the Northern Pacific westward was begun in Minnesota in June, 1870, with the famed iron-ore port of Duluth, then a hamlet, as its Great Lakes terminus. Six months later work was started in Washington on the Puget Sound end, the franchise and land grant awarded by Congress stipulating time limits for certain phases of the enterprise. Monetary matters were handled by the house of Jay Cooke, which had been identified with Civil War finance. This largest of American banking firms fell in the panic of 1873, and railroad construction took a 5-year holiday; but the line had crept across the Minnesota and Dakota plains to reach the Missouri River at Bismarck, and the thick ice spanning that great stream through the long winter season was made to serve in lieu of a bridge to carry track.

But the depression did not prevent Montana pioneers from being dissatisfied with the sketchy freight service given by tiny steamboats creeping up the Missouri and Yellowstone rivers, or from at least talking railroad. In 1875 they held a railroad convention at their capital city, Helena, and solicited propositions from the Northern Pacific and from the com-

TRACK WORK

These days air power does most of the heavy work of maintaining track. The pictures on the opposite page show crews tamping ballast with tools powered by crawler-mounted air compressors of which the line has purchased 34 units in recent years. Air also drives spikes (center) and applies grout (above) in sections where the ground requires consolidation.

pleted Union Pacific and Central Pacific. Historically, it is interesting to note in retrospect that attendance of Northern Pacific's chief engineer and vice-president at Montana's state legislative assembly in January of 1876 involved stage travel that was not without its hazards. That trip preceded by six months the noted Custer massacre on the Little Bighorn River. The Custer battleground is a considerable distance east of the Montana capital and was not far from the main stage road.

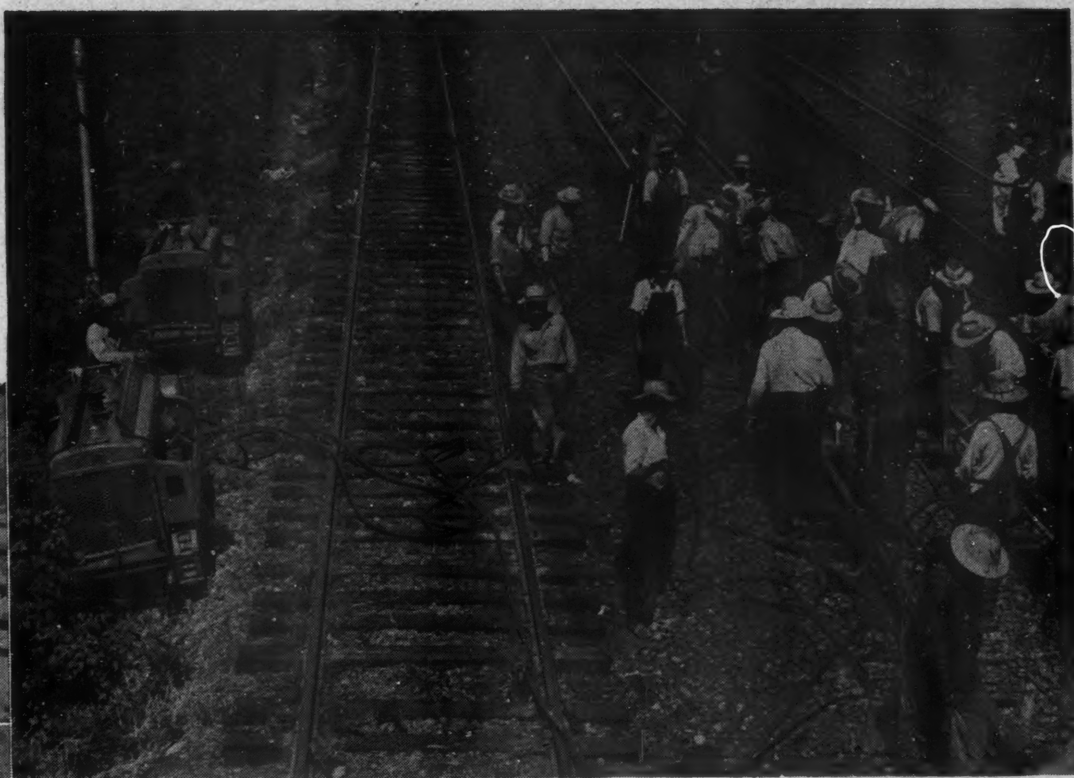
The scenic wonderland, Yellowstone Park, was reserved as a national playground by Congress in 1872, but the Northern Pacific had not yet become the "Yellowstone Park Line." It did not have to await a world war, or even completion, however, to assume military significance. During that pioneering era, the Civil War generals W. T. Sherman and Phil Sheridan were successively in charge of the Western Indian Campaign, doing their best to give Montana colonists and travelers "scalp insurance" of a sort from great roving bands of Sioux and Blackfeet who retreated into Rocky Mountain hideouts. Harrassed settlers got some respite from Indian depredations because of the warriors' concerted effort to destroy Northern Pacific survey and construction parties. Sherman and Sheridan received high tribute for their contribution to the railroad project and, in turn, rated the growing line as a great military asset in this most troublesome of Indian countries.

Pioneering citizens of the Pacific Coast exhibited no less civic spirit during this period than did their contemporaries in Montana. Portland, Ore., had become a sizable inland port on the Columbia River before Puget Sound boasted any community of comparable size. Competition between Portland and the younger port cities of the Northwest was not devoid of drama and intrigue. The primary objective of each was the wooing of a transcontinental railroad not merely to secure for itself branch-line service but to become its one and only, or at least its principal, western terminal. Builders of the Northern Pacific could not discount Portland's dominance, but at the same time had to weigh small but ambitious Seattle's generous offer of cash, bonds, and large waterfront areas against the lure of choosing and actually creating their own Puget Sound terminus.

As vicissitudes of finance and other handicaps delayed Northern Pacific construction, the impatient port cities began to flirt with other railway builders. A Portlander suggested running a line from Portland across the Cascades to a junction with the Central Pacific at Winnemucca, Nev., on the Humboldt River. Correspondence and interviews were carried on for several years, a route explored, and Collis P. Huntington of the Central Pacific formally offered to build the line provided Oregon would pay a good share of the costs and promise not to levy taxes on the property until profits exceeded 10 percent.

While railway giants were sparring for position in the vast forests of the Northwest, a foreign interloper stepped into the arena; and his quick rise to full stature is typical of the fabulous era in which he lived. Born Ferdinand Heinrich Gustav Hilgard in Munich, Henry Villard ran away to America at eighteen, became editor of a German-language paper, and later correspondent for the *New York Tribune* with the Army of the Potomac in the Civil War. Entering railway finance in 1871 by representing the interests of European bondholders in short-line Pacific Coast railroads, he gradually secured virtual monopoly of water- and rail transport systems radiating from Portland.

Obtaining a franchise to construct a railroad along the south shore of the Columbia, he conspired with Jay Gould to effect a connection with the latter's Union Pacific. When Huntington of the Central Pacific got wind of this intrigue he promptly threatened Gould with diversion of all California freight over a southern line Huntington was building towards New Orleans. Villard and Gould carried on their project with objectives discreetly camouflaged, finally bringing about a junction to form the present Union Pacific running into Portland. Perhaps Villard gained greatest financial renown by engineering his famous Blind Pool by which he induced friends to hand over to him several million dollars to be used for



an undisclosed purpose. This turned out, in time, to be the buying of a controlling interest in Northern Pacific, and Villard became president of that line in 1881.

The Northern Pacific, with rails advancing from east and west, drove its golden spike with due ceremony at a point 54 miles west of Helena in September of 1883. It was not, of course, the convenient transcontinental route into which it has gradually evolved through the intervening years, for a passenger setting forth from the Twin Cities had to go north to Duluth to start his westward journey. At Wallula, near Pasco, Wash., he was taken across the Columbia River and then into Portland over tracks of the Oregon Railroad & Navigation Company. From Portland he had to travel by river boat as far as Kalama, southern terminus of the Northern Pacific track running north to the towns on Puget Sound.

Meanwhile, many betterments and extensions have been made, including a line from Pasco to Tacoma through Stampede Tunnel in the Cascades, completed in 1888. The Spokane, Portland & Seattle Railway now provides service between Portland and Pasco. This short stretch follows the north bank of the Columbia and is owned jointly by that road and the Great Northern. Many improvements in location and structure have been made in Northern Pacific's double-track line between Portland and Seattle, including bridging of the Columbia at Vancouver, Wash., in 1908. This route is now used also by the Union Pacific and the Great Northern, and during the recent war was an extremely vital military railroad. The great copper camp of Butte, Mont., was given through train service in 1890.

In its exploration, building, and operation, the Northern Pacific has never been in any sense a 1-man railroad but represents the fruits of years of coöperation marked by many vicissitudes. C. E. Denney, its president, recently stressed this point in commenting on the system's wartime role when he said, "It was possible to handle this tremendous increase in traffic during a period of labor shortage only because of the extra efforts of our officials and employees. These services were rendered cheerfully and almost without regard to the hours of work required because of the feeling that each individual was doing his or her bit in the total war effort."

As the pioneer line into the Northwest, the Northern Pacific has had many firsts in its long career, among them the operation of a 48-mile railroad built by the Navy on rugged Olympic Peninsula from Shelton, Wash., to its Bremerton Navy Yard. The giant dry docks and cranes of that base have been working overtime in repairing damage done to our flattops and other fleet units by kamikaze flyers at Okinawa. This direct rail connection with Bremerton not only sped delivery of materials and ammunition but eliminated the hazard involved in the water transport of explosives through Puget Sound. The Northern Pacific tracks radiating from Seattle have been indispensable suppliers of the local Boeing plants, birthplace of the renowned Forts and Superforts.

As on all western trunk lines, there was a notable rise in all classes of traffic from 1940 to the end of the war. Passenger train-miles multiplied more than five times, and freight-ton miles increased 130 percent. The fact that taxes on the 1944 gross earnings of 156 million dollars amounted to nearly 29 million illustrates how great a percentage of railway profits went directly toward the winning of the war. The spending by each system of its remaining share of wartime earnings no doubt will considerably influence its future financial position and its performance as a competitor for traffic in the accelerating tempo generally predicted for transportation in the postwar era.

In extolling the great potentialities of the Northwest, Jay Cooke's publicity men waxed so enthusiastic that the region came to be known lightly as "Jay Cooke's Banana Belt." The productivity of this great frontier area in such essentials as lumber, wheat, wool, meat, and minerals has indeed grown with the pioneering rail line so that Cooke's forecasts sound much less Utopian today than they did some 70 years ago. The steady development of the Northwest, including Alaska, with increasing shipping in the many excellent harbors of the Washington-Oregon coast, has continued to appeal to railroad builders. Now, Northern Pacific must reckon with two more or less paralleling railroads, as well as with highway and airway carriers.

During the years 1940-1945, inclusive, Northern Pacific has put in service new equipment consisting of 9280 freight cars, 55 road locomotives of which eleven are 5400-hp. diesels, and 56 diesel switchers. On order are six 4500-hp. diesel passenger locomotives, four 6000-hp. freight diesels, 36 passenger coaches, 24 sleeping cars, six diners, and twelve head-end cars. The new passenger coaches, all of lightweight construction, are scheduled to go on the transcontinental run late in 1946. Five hundred box cars, ordered late in 1944, were put in service in the first quarter of 1946.

Modernization of shop facilities has kept pace with the increase in rolling stock and has been accomplished by building a fine locomotive repair shop containing a Whiting drop table for the speedy dismantling of engine drivers, a new storehouse, and a model system maintenance-of-way-equipment shop at Livingston, Mont. A diesel-electric repair shop has been erected at Auburn, Wash., and work is underway on a $1,750,000 car-construction and repair shop at Brainerd, Minn. Various needed machine tools have been added, and an aggregate air capacity of 12,475 cfm. has been obtained with the purchase of six new stationary compressor plants for the different shops.

The beginnings of President Denney's railway career were closely associated with signaling and track, and the track structure remains one of his primary interests in allocating wartime income. Some major improvements have been made in the road, including a new 3000-foot concrete-lined tunnel through Bozeman Mountain to accommodate larger rolling stock. A total of twenty changes to bring about better alignment and curvature were completed in 1944 alone. A 16.5-mile change in North Dakota, which will shorten the line 9.3 miles, has been approved. Banks have been widened and drainage improved along much of the way, and better drainage and stability of track for high-speed operation have been assured by the extensive distribution of crushed rock, some 1,400,000 yards of new ballast having been placed in 1945. It is typical of the current track program that about 36,000 tons of new rail and 800,000 ties were laid the same year.

While contracts have been let for line changes and some bank widening, work on track has been handled by company forces supplemented during the war by a considerable number of Mexican Nationals brought in on temporary permits by arrangement with the Government of Mexico and under contract for 6-month periods. For some time prior to the war the increasing scarcity of track labor, combined with more exacting standards of track maintenance set by higher train speeds, had served to high light the growing importance of maintenance-of-way equipment, with the result that its repair in the shop and maintenance in the field have been thoroughly systematized. As war economy brought work equipment into even greater prominence, as much of the desired types was bought as WPB approvals and delivery by manufacturers would permit. Such purchases by the parent system and by the affiliated Spokane, Portland, & Seattle include 34 eight-tool crawler-type, pneumatic tie-tamper units for the general resurfacing of track. Several power shovels and tractors of various sizes also have been acquired for every sort of earth-moving job from plowing fire guards to sizable grading operations.

With the return of peace, the great scenic playground of the West with its superb parks and hundreds of dude ranches is no longer out of bounds to the vacationist and sportsman. The spacious hotels and lodges scattered throughout Yellowstone National Park are being readied for what is expected to be a record season, and no doubt the tide of men that not so long ago traveled westward to wage war will be largely replaced by those seeking Mother Nature for health and inspiration.

IMPROVING TRACK ALIGNMENT

A scene near Cle Elum, Wash., on the eastern slope of the Cascades, showing relocation of track to reduce curvature. The old line is at the left. As many as twenty changes of this kind were made in one year alone.

Compression Distillation of Sea Water

Robert G. Skerrett

U. S. Marine Corps Photos

ON SAIPAN

The camouflaged position of the vapor-compression units that produced potable water for our troops on Saipan is illustrated at the top. The other picture is an interior view showing one of the Kleinschmidt portable stills.

ONE of the best kept of our wartime secrets was how we were able to furnish our fighting men with vitally necessary fresh water especially in regions such as the Pacific islands where rainfall at unpredictable times offered the only supply. That problem had been foreseen and taken care of well in advance of Pearl Harbor primarily by a group of experts in the laboratories of Arthur D. Little, Inc., of Cambridge, Mass. Those men brought an unfamiliar method of distillation to a stage where it was possible to obtain fresh water from sea water far more economically than by the means ordinarily employed for that purpose.

In distilling fresh water from salt water there is generally a relatively wasteful use of the heat energy involved, with a corresponding expenditure of fuel, and engineers have long sought to effect higher degrees of heat recovery and reuse. We have examples of this trend in many industrial processes such as the refining of sugar and the recovery of salt from brine, but even further improvements were desired.

Boiling or vaporizing of fresh water at sea level begins when the temperature reaches 212°F., and if the concentration of a water solution is increased, the boiling point is generally raised correspondingly. In the case of salt water it is approximately 213°. However, if boiling takes place under a partial vacuum, then the vaporizing temperature is lowered as the vacuum is increased. Therefore, the effectiveness of the evaporating action of steam at normal pressure and temperature may be prolonged by successive boilings in vacuum pans, each subjected to increasing vacuum as the vapor passes from one still or pan to another. Even if there were no loss of heat in these transfers, operation of the vacuum pumps at the several stages would require steam or electric energy—adding by so much to the cost of the process. Keeping these facts in mind, it will be easier to understand what has been accomplished by Arthur D. Little, Inc., which has been doing notable things for American industries for 60 years.

As early as 1934, that organization offered its technical resources to the Navy, which was eager for such civilian help, but there was then no way of compensating for it. Consultation disclosed a number of more or less pressing naval problems, among them that of supplying fresh water to some types of naval craft and to U. S. Marines who might have to win and hold positions on waterless islands. Dr. Robert V. Kleinschmidt of Arthur D. Little, Inc., immediately visualized the answer in a unit based on the compression-distillation principle. The first model was built in February, 1936, but fell short in a number of respects, and not until March, 1941, did a specialized model for shipboard use reach a stage that warranted putting it into production. But before that happened, Doctor Kleinschmidt was mustered into the Navy.

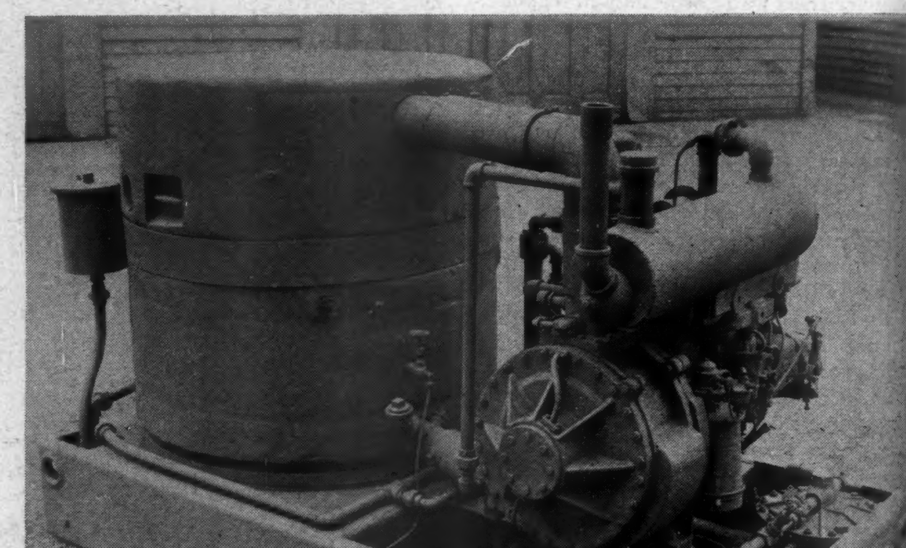
In preparing for eventualities in the Pacific, the Navy planned to employ submarines to the fullest possible extent, and this hinged largely upon the availability of an abundance of pure fresh water for their storage batteries—the primary source of propulsive energy when the boats operate submerged. The first of the compression-distillation units were therefore

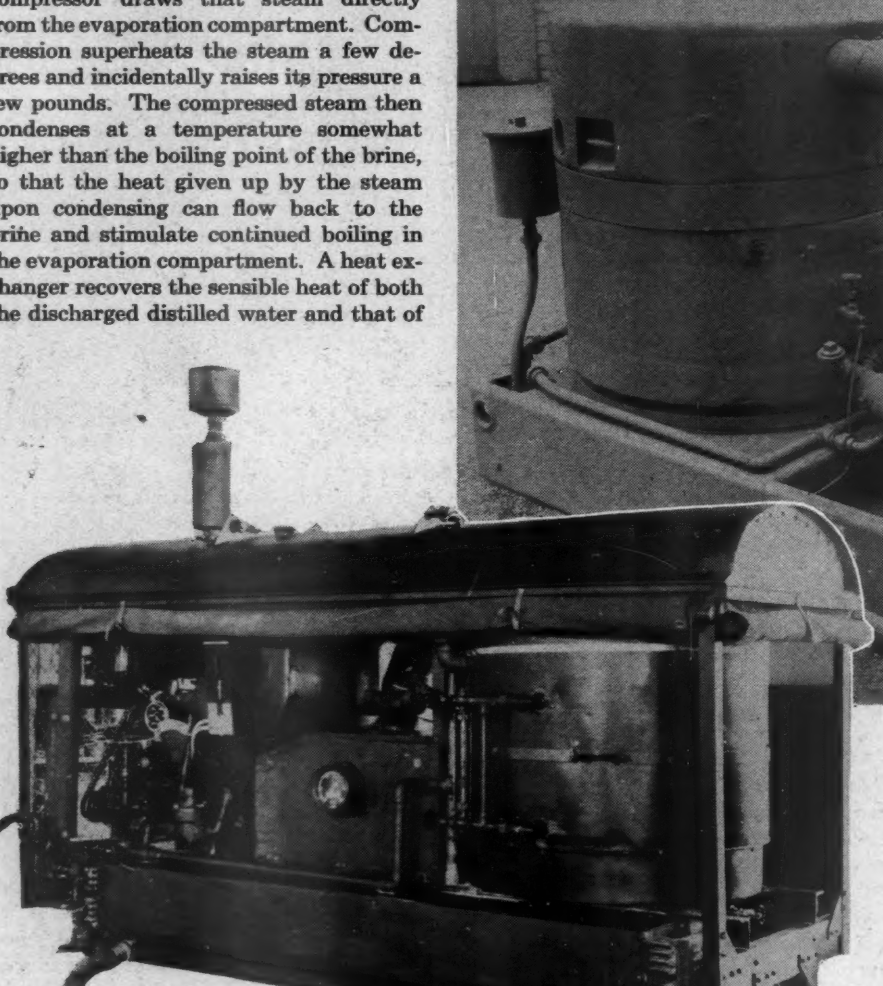
placed aboard such craft, and their effectiveness in that service widened interest in them in both the Army and the Navy. The Marine Corps and the Army wanted portable units that could be put on shore and driven by internal-combustion engines instead of by electric motors, as were those for submarines that could use current either from the storage batteries or the engine-driven generators. Models of the portable type were under development when the Japs struck at Pearl Harbor.

When Doctor Kleinschmidt entered the Navy, one of his associates at the Cambridge laboratories was Allen Latham, Jr., head of the Mechanical Development Department, and upon him fell the responsibility of furthering the development of the vapor compression stills, as the units are also called. It is to him that we are indebted for much of the information in this article. "Fundamentally," according to him, "the high fuel economy of the Kleinschmidt process depends upon compression of the vapor leaving the evaporation compartment so that it can be used in the steam chest in place of process steam." Mechanical compression further raises the temperature of the steam coming from the boiling sea water, and the compressor draws that steam directly from the evaporation compartment. Compression superheats the steam a few degrees and incidentally raises its pressure a few pounds. The compressed steam then condenses at a temperature somewhat higher than the boiling point of the brine, so that the heat given up by the steam upon condensing can flow back to the brine and stimulate continued boiling in the evaporation compartment. A heat exchanger recovers the sensible heat of both the discharged distilled water and that of the dense hot brine, which is exhausted from the evaporator and which carries with it the salts of the sea water.

The heat exchanger consists basically of three concentrically arranged tubes, the smallest one running through the center of the assembly and carrying off the discharged hot brine. The next larger is the tube through which incoming sea water passes on its way to the evaporation compartment. Encircling the latter is the fresh-water conduit which, also being hot, transmits a good deal of its heat to the feed from the sea. The hot fresh water and the hot brine raise the temperature of the entering sea water to within a few degrees of the boiling point before it reaches the evaporation compartment. Thus, through the mediums of compression and an efficient heat exchange, the results obtained are virtually equivalent to those that might be realized when a number of interconnected vacuum pans is used.

Mr. Latham explains the steps involved in the process as follows: "Normal operation is preceded by a period of heating to bring the apparatus and its contents to operating temperature. As soon as the evaporator has been filled with steam, the still may be turned 'on stream' for continuous operation. The sea water enters by way of a triple-passage, liquid-to-liquid heat exchanger which extracts heat from the outgoing distillate (fresh water) and the brine to heat the feed. The feed, then at about 207°F., is next delivered to the evaporator where it mixes in a relatively large volume of brine that circulates by natural movement through the vertical tubes. Steam at, or slightly above, atmospheric pressure is led from the evaporator space through an entrainment separator to the compressor which raises the pressure to about 3 pounds per square inch gauge, thus raising its saturation temperature to about 222°. Since the brine in the evaporation space boils at about 213° there is a temperature differential of approximately 9° between the compressed steam and the boiling brine, which permits a transfer of heat from the compressed steam to the boiling brine. Substantially all of the latent heat of the compressed steam is used in maintaining evaporation in the evaporation space;





EARLY AND LATE UNITS

At the left is pictured the first gasoline-engine-driven type that blazed the way for the development of portable outfits for the use of invasion forces. The other view shows a recent compact unit arranged for gasoline-engine operation. It can produce 1800 gallons of fresh water from sea water daily.

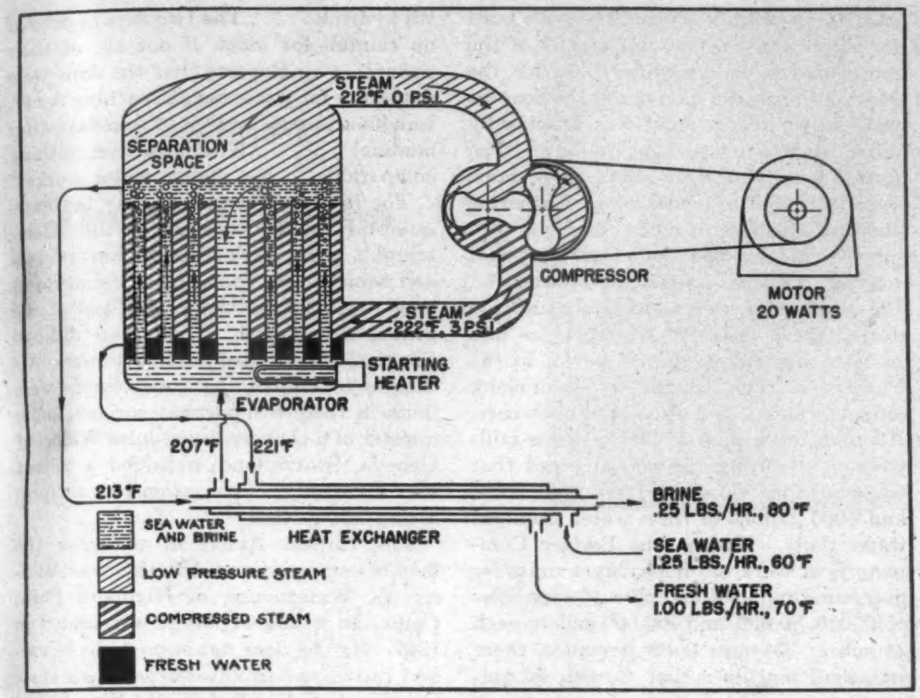


DIAGRAM OF PROCESS

Eighty percent recovery of fresh water is made from the sea-water input, the remaining 20 percent being a concentrated brine that is discarded.

and, therefore, no separate condenser or cooling water is required.

"With a unit of 1000-gallon-a-day capacity, the hourly production of one pound of distillate requires an electric power expenditure of about 20 watts. To produce the same amount of distillate in a single-effect evaporator would require approximately 300 watts. From this it should be apparent that the compression-distillation process has an economy equivalent to some fifteen or more 'effects,' as that term is applied when a series of vacuum pans is used, and that such a unit is far easier to operate than a multiple-effect unit. The connections, the heat-transfer apparatus, and the controls are as simple as those on a single-effect evaporator. Ordinarily, control of the operation is made entirely through adjustment of the feed flow. That this process requires little attention is evidenced by the fact that on shop tests units set up for manual control have been left running day and night for as long as a week without adjustment of any sort."

When the compression-distillation process is applied to salt water, the evaporation surfaces are affected by scale formation, and this necessitates shutdown at proper stages for removal. In some ways, the effect of scale formation on the performance of the compressor evaporator is more noticeable than it is in the case of more conventional types. On this point Mr. Latham says: "The added resistance to heat transfer produced by scale requires an increase in compressed steam pressure in order to maintain constant output. This results in more energy entering the system by way of a compressor. In all-electric drive, for example, the added energy input from the compressor may be compensated for by a decreased use of the electric heater, as shown in the accompanying diagrammatic illustration, thereby maintaining practically constant total electrical input regardless of scale formation.

"But a rather different situation exists in the case of internal-combustion-engine drive equipped for waste heat recovery. In this case, the waste heat is more than sufficient to perform the same function as does the electric heater in electric drive. Scale formation leads to a heavier load on the engine, which, in turn, gives up more waste heat which, of course, is not needed for operational leeway. Thus the engine-driven unit is characterized by low fuel consumption when the evaporator is clean, and by a gradual increase in fuel consumption as scale formation progresses. In spite of this, the over-all economy of engine drive is difficult to surpass."

The results of a field test of an experimental unit of the latter type confirmed the foregoing conclusion. It seems that a wide variety of prime movers may be used for the compressors in the Kleinschmidt process, and they may entail a considerable range of thermal efficiencies. Up to the close of the war, the distillation equipment developed for the purpose had capacities generally lower than 250 gallons per hour. However, with large units, and under typical industrial practices, it is said that higher efficiencies and possibly greater savings may be realized. As to over-all fuel economy, the latest compression stills in service average at least 175 pounds of distillate for each pound of fuel consumed. This is believed to be the highest performance yet attained by any system of evaporation, with the exception of cases where solar evaporators are employed or where the distilling systems are tied into other plant operations, and is in a ratio of three to four times greater than that obtained up to now with efficient conventional systems in which fuel is burned to provide the necessary heat.

Blower types of compressors have been largely used in Kleinschmidt apparatus built for the Army and Navy, and they have done good work under the limitations that proved acceptable in battle areas. But it is said that this type is not "readily adaptable" when a unit must have a distillate output of more than 300 gallons an hour. However, as Mr. Latham points out: "Current development of improved types of compressors may make a wider choice of satisfactory compression equipment possible in the near future." He is also convinced that the status of the art of compression-distillation is advanced sufficiently to take its place as a radically new factor in the field of distillation and evaporation. The same procedure and equipment can be utilized where the end product desired is a concentrate rather than a distillate, as in the production of maple syrup from raw sap, in the processing of condensed milk, and in the handling of thousands of other much-used commodities.

The experiment that started in the laboratory of Arthur D. Little, Inc., eventually took the form of thousands of distilling units capable of providing enough pure water to meet the daily needs of more than a million men. The im-

THE MAN RESPONSIBLE

Commodore Robert V. Kleinschmidt, USNR., who initiated the development of vapor-compression distillation at the laboratories of Arthur D. Little, Inc., prior to the war and who has resumed his connection with that organization after a period of active naval service.

portant job of translating the laboratory models into dependable service units that could be built on a large scale by repetitive operations was entrusted to E. B. Badger & Sons Company, of Boston, under a co-operative arrangement with Arthur D. Little, Inc., who held the controlling patent rights. How well that organization, with a business background of more than 100 years, met the emergency is a matter of official record.

At the start of the work, the Badger Company, under the supervision of Doctor Kleinschmidt, produced a unit having a daily capacity of 500 gallons. This was tested by the Navy in a submarine. Based on its performance, the Navy authorized the design of a still supplying 750 gallons daily. It took from six to eight months to construct one that would operate satisfactorily. One of this type was sent to the experiment station at Annapolis for testing, and 2000 of them were ordered when the last of the kinks had been ironed out. Even so, after some use afloat, certain changes in design were found desirable to make the machines stand up fully under the rigors of wartime conditions. Then a completely different type was developed that proved highly successful.

Capt. T. J. Bay, USN., of the Navy Department, made many helpful suggestions to the manufacturers in their efforts to evolve compression vapor stills suitable for shipboard, and in the early stages of the development Lieut. Col. E. E. Linsert and Maj. J. H. Goodwin, both of the U.S. Marine Corps, did the same thing in the case of the portable type. The stills built for shipboard service were mainly of the motor-driven order, while those for the Marine Corps, the Army, and the Seabees were nearly all portables driven either by diesel engines or gasoline motors. The former were placed on submarines, mine sweepers, floating workshops, submarine chasers, destroyer escorts, tankers, submarine rescue vessels, landing craft, net tenders, dredges, coastal transports, etc. Portable units were effectively utilized during the invasion of North Africa late in 1942 and did yeoman's service in the Pacific on such islands as Kwajalein, Saipan, Peleliu, Iwo Jima, and elsewhere. All told, more than 10,000 of these stills were used during the war in sizes that could produce 750, 1000, 1500, 2000, 3000, and 6000 gallons of fresh water from sea water daily. Today, the Badger Company is at work on much larger units for peacetime applications and with capacities of 25,000, 50,000, and 100,000 gallons each 24 hours. To meet lesser demands, there are small machines that furnish 50 gallons.

On many occasions, the mobile units proved of the greatest value to our fighting men when drinking water could be obtained only by distilling sea water. A single example is abstracted from an article by Staff Sergeant Jack Vincent in the *Marine Corps Gazette* of October last and entitled *Water on Iwo.* "Iwo was probably the most barren island ever invaded by such a large American force. There were no streams, and the few hot sulphur springs gave up water too brackish to drink . . . . . The Iwo Japs depended on rainfall for most, if not all, of their water . . . . . Reports that the Japs were desperate for water began reaching American lines as early as D + 10 (ten days after landing) . . . . . The Japs had nothing comparable to our mobile water works."

The historically minded may be interested in the background of the Kleinschmidt compression-distillation process and wonder why the engineering world so long neglected to make wide use of the principles involved. There were difficulties that discouraged prior inventors. Attempts to employ jet compressors were made in 1856 with partway success; and a quarter of a century later, Jules Weibel of Geneva, Switzerland, obtained a patent that involved the utilization of a reciprocating compressor.

The earliest American to enter the field of compression distillation was Addison G. Waterhouse, of Highland Park, Conn., to whom a patent was issued in 1897. But he does not seem to have carried his invention any farther than that. It was not until after World War I that any noteworthy progress was made. This took the form of a few commercial installations that were custom built by two or three European firms. In this country, apparently nothing was done to put mechanical compression distillation to industrial use—at least nothing on the subject appeared in technical journals—until Arthur D. Little, Inc., and E. B. Badger & Sons Company, through their joint efforts, brought about the present advance of great practical promise.

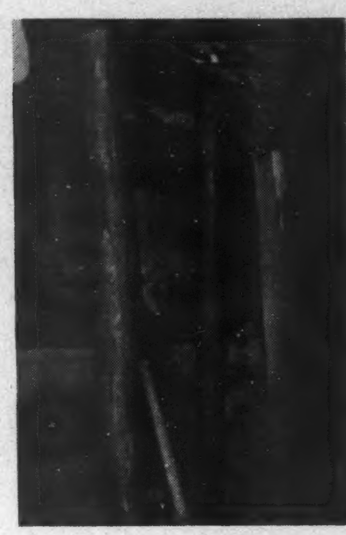
U. S. Marine Corps Photo

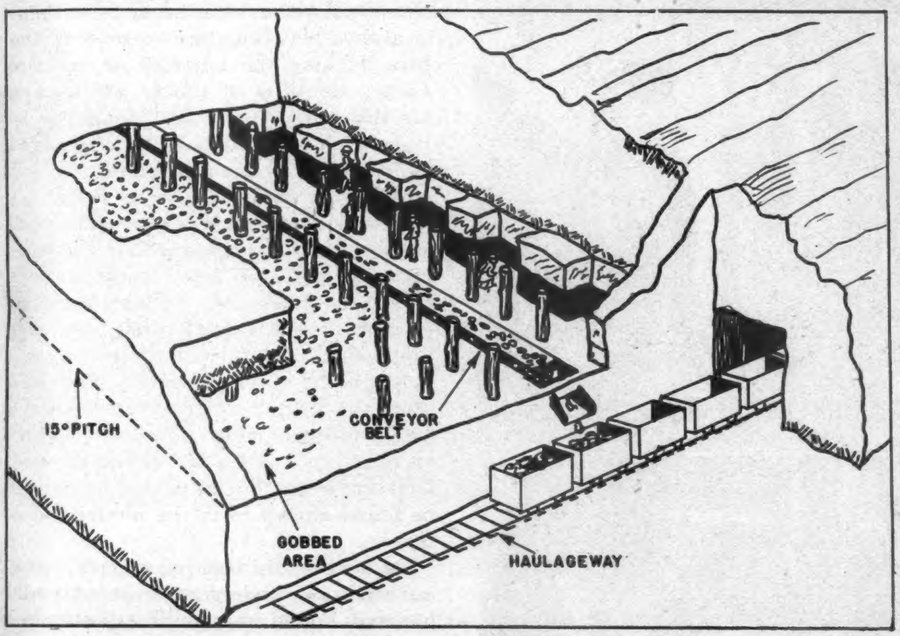
ANOTHER SAIPAN PICTURE

Loading canisters with distilled fresh water to supply our troops while they were battling the Japanese for possession of that Pacific island. Lacking distillation equipment, the enemy had to depend mainly on rainfall and suffered greatly from a shortage of potable water not only on Saipan but on Iwo Jima and elsewhere.

Copper from Mexico

Roger V. Pierce





THE MINING SYSTEM

As shown in the perspective sketch, a conveyor belt runs parallel and close to the mining face. Fifteen or twenty miners, stationed about 8 feet apart and using picks and shovels in the soft material, sort the ore and shovel it onto the belt that dumps it into a chute above the haulageway. The waste is thrown across the conveyor into a gob area. After a strip 4 to 6 feet wide has been mined, the belt is shifted that much nearer the ore face and the cycle is repeated. The conveyor is dismantled into 6-foot sections and can be moved by three men in half an hour. One of the miners is shown at work at the top. This picture illustrates the close timbering that is required.

ON THE peninsula of Southern California, and about 500 miles below the border between California and Mexico, there has existed since 1885 a flourishing copper-mining industry that has produced for and outlived two world wars. Like all ore deposits that are worked steadily, the end eventually comes in sight. That is now the case with the famous French-owned Cia. del Boleo, S.A., copper mines, which can really be listed as a war casualty.

Within the next three or four months the story of this enterprise will come to an end. What little ore remains will be brought to the surface, all machinery will be removed, and another page in the history of mining will be written. The property is operated by Rothchild-Miraband interests and is located near Santa Rosalia, which is on the Gulf of California. That city has a population numbering between 6000 and 8000; but in its heyday, when it formed the center of a copper-mining industry which worked four or five shaft mines, it boasted 15,000 inhabitants. Now that the ore reserves are nearing depletion, there is every reason to believe that history will repeat itself—that there will be fewer heads to count in Santa Rosalia at the next census-taking.

The closing of the copper workings will terminate an enterprise that has operated one of the most interesting mining systems on the North American Continent. The ore-bearing area is 12 miles long and approximately 1 mile wide. The veins dip eastward toward but not actually under the Gulf of California. The San Luciano Mine, which is the only one that is still producing, is 9 miles south and west of Santa Rosalia. At that point the vein varies from 2 to 3 feet in thickness and has a slope or pitch of 15°. The ore body is served by a vertical shaft that has a diameter of 17 feet, is divided into two compartments, is lined with unreinforced concrete 1½ feet thick, and was sunk through limestone, sandstone, and conglomerate to a depth of 820 feet.

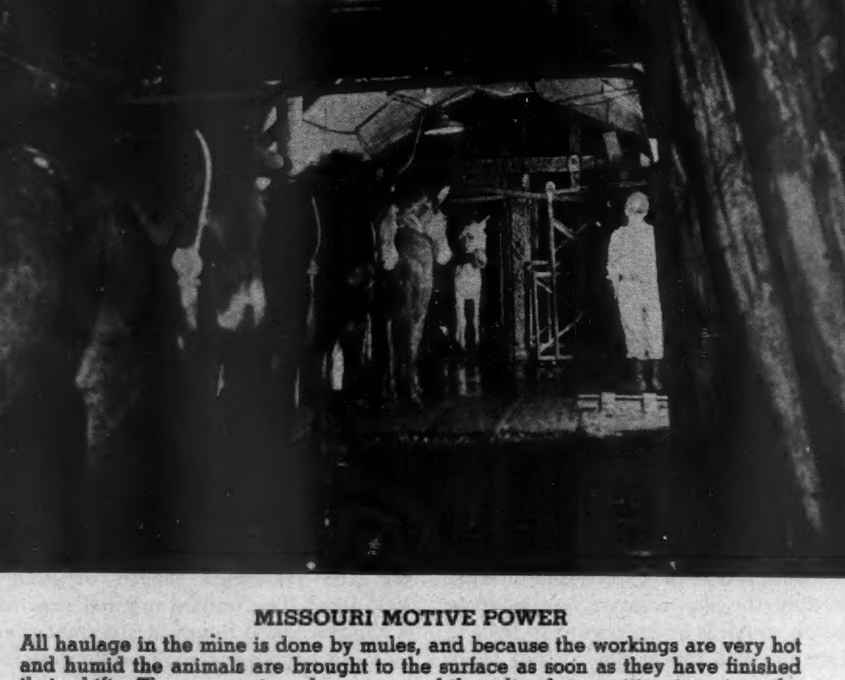
The ore is of low grade and very soft, being composed of clay impregnated with copper sulphides and assaying about 3½ percent copper. The hanging wall or top of the vein is of soft-clay formation, while the footwall is a cemented conglomerate. The aggregate is quite hard and consists of materials ranging from large boulders to fine particles of sand.

The present operations are 600 feet below sea level and are producing 300 tons per shift. Because of the heat (90°F. and higher) and the extremely high humidity underground, working conditions there are difficult and create a ventilating problem. Even with large fans and blowers forcing air into the various mining sections it is not an easy matter to keep the temperature down. Large volumes of water also have to be coped with in reclaiming the last of this low-grade copper vein from the earth's depths.

The main haulage level leading to the ore body from the shaft station is a timbered drift 10x7 feet in cross section. It is double-tracked for a considerable distance and the maximum length of haul is 2000 feet. The mining method practiced is what is called longwall advancing, and by it an opening or inclined drift or flat raise is driven up along the footwall for a distance of 150 feet. In this opening is installed a 5-ply conveyor belt, 19 inches wide and 150 feet long, provided with a ⅛-inch rubber coating to protect it

against abrasion. It is powered by an 8-hp. electric motor and moves 100 feet a minute. There have been numerous occasions when belts have delivered loads on to a mother or cross conveyor. The longest belt used is 350 feet in extent and travels on both plus and minus grades. These carriers serve to pull ore up minus 28 percent inclines and to transport it down 20 and 22 percent grades, depending, of course, on how wet or how dry it is.

Because the ore is so soft, the problem is one not so much of mining the vein as it is of rapid timbering of the excavated areas. To facilitate this operation, miners are stationed along a conveyor at intervals of 7 feet 4 inches. The ore is broken from the long, low face with hand picks, except in the haulage drifts which are driven in the footwall of sandstone or of conglomerate. There it is necessary to drill holes to break up the rock, and this work is done with Ingersoll-Rand Jackhamers which are supplied with air by a 50-hp., track-mounted compressor of the same make. Conventional 7/8-inch drill steel is used with 2-inch-diameter starter bits and 18-inch changes.



MISSOURI MOTIVE POWER

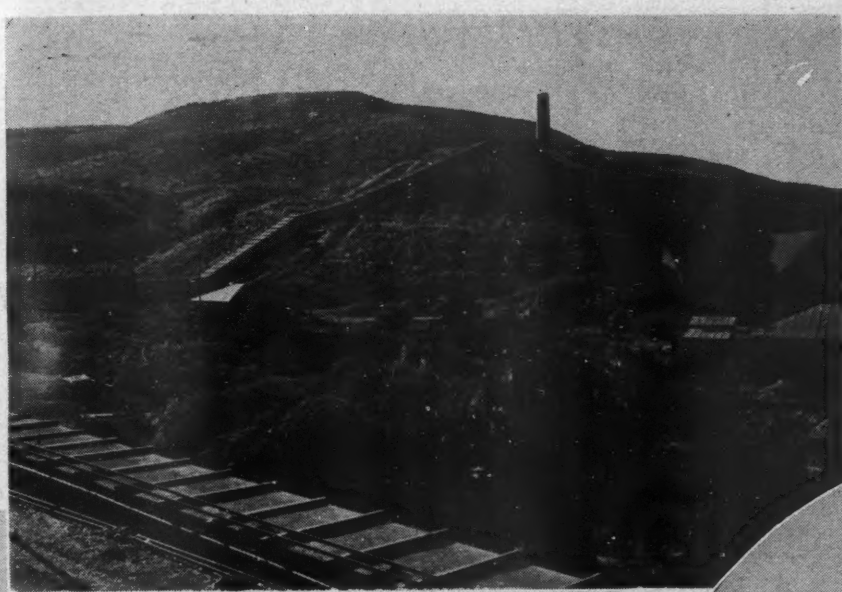
All haulage in the mine is done by mules, and because the workings are very hot and humid the animals are brought to the surface as soon as they have finished their shift. The upper view shows some of them lined up waiting to get on the cage to be hoisted. The other picture was taken looking in the opposite direction, toward the shaft. A white mule, facing the camera, may be seen about to step off the cage, while those in the line at the left are through for the day. The animals display great intelligence and orderliness during the entire transportation procedure involving a lift of 635 feet.

The waste is sorted from the muck by hand and thrown over the belt into the gob or mined-out area, while the ore goes onto the conveyor. The vein, being extremely rotten and containing high amounts of clay and water, presents a tough sorting problem, and 40 percent of the excavated material is stacked across the belt into the gob. In consequence of these conditions, the San Luciano is one of the few metal mines in North America where scraper hoists have not been profitably applied.

A strip 4 feet wide is mined the full length of the rib as a unit, and then the whole belt is shifted, in sections, so that it is always between the two rows of timbers flanking the longwall or ore face. Large quantities of timber are required for this purpose and are brought in by Boleo Company boats from Washington and Oregon. It is unframed for the most part and generally follows a rough pattern of square-set timbering. The posts are usually 4x4 inches in section and 6 feet high; the caps are 7 feet 4 inches long and 5 inches in diameter. This supporting framework is advanced toward the mining face each shift, and the conveyor is moved along with it, of course. The latter drops the ore into a chute from which it is loaded into cars pulled by mules. Here is an operation that is one of the most interesting in the line of animal haulage to be found anywhere in the mining industry.

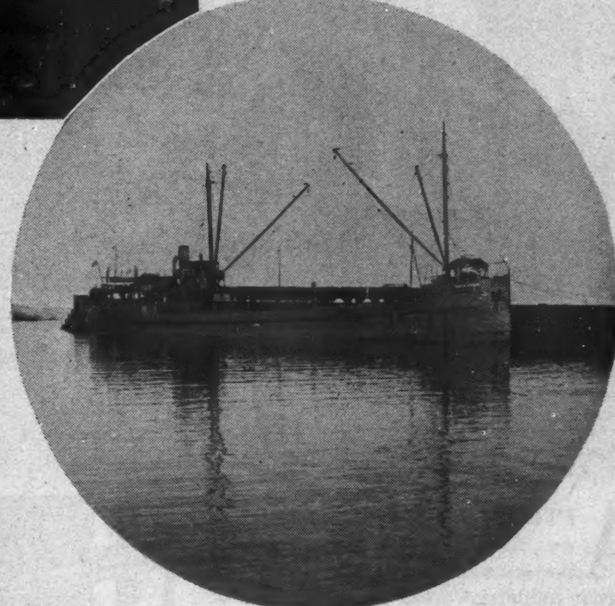
As has already been mentioned, working conditions underground are extremely hot and humid and, unlike most mines where mules or horses have been or are being used, the animals are lowered each day and brought up again at the end of each shift. They go through the same routine as the miners. It is worth going below to see as many as 15 or 20 mules come out of the various working areas and line up single file at the shaft station in as orderly a manner as the men. In the meantime, a double-deck cage descends with one night-shift mule on each deck. When the cage tender opens the gate for them, in turn, the animals step out and walk alongside the string of day-shift mules without looking to the right or to the left. One gets the feeling that they are not on friendly terms. If one group does have something to blame the other for, there's no fuss about it. As soon as one animal leaves the cage another enters, and so the procedure continues until the shift has been changed. While they are being hoisted 635 feet up the shaft, the mules stand very still, sensing, no doubt, that their safety depends upon it.

The animals work on an average ten years before they are retired or become



MINE, FURNACES, ORE BOAT

The mine headframe and the nearby waste dump are shown at the lower left. At the left is a view of the smelter at Santa Rosalia to which the ore is shipped. It contains three reverberatory furnaces that are insulated with a 4-inch layer of pumice-stone concrete. The pumice is obtained from local extinct volcanoes. The "Santa Agueda," one of the boats that ply between Santa Rosalia and Tacoma, Wash., is pictured below. Blister copper of more than 99 percent purity is delivered to Tacoma to be refined, and pyrite for use in the Santa Rosalia smelter is brought back from British Columbia.



too old. They are well taken care of and fed hay and corn to keep them in good condition. Before they are taken underground they are broken in on the surface, and then three or four days' training down in the mine suffices to make them dependable. But they are not always tractable, as one incident observed by the writer would seem to indicate.

It happened that a night-shift mule did not immediately step out of the cage when the gate was opened for him. The waiting animal, probably hot and tired, became impatient. He laid his ears back, reached out, and bit the poky creature. He really meant business. There was a scramble, but in a minute or two, when the day-shift mule could enter the cage, all was quiet again. Normally, however, the change in "motive power" is effected with such precision as to amaze the onlooker.

It is claimed that the San Luciano mules will not get on the cage to be lowered until the whistle blows. On the other hand, they will not go up until their day's work is done. They will pull a train of eight cars, each having a capacity of half a ton; they will pull less; but if their load is increased, if another car is added, nothing happens—the animals refuse to budge.

When a train reaches the shaft, four ore cars are run onto the cage, two on each deck, and are lifted at a speed of about 1800 feet a minute by a 480-hp., 2-drum hoist. At the surface the material is dumped into a bin from which it is fed onto a conveyor belt for check-sorting. Any waste hoisted is also gone over so as to make sure that all commercial copper ore is recovered. Useless material goes on a waste pile and is handled by automatic dump cars that are pulled up the grade by a 25-hp. hoist with a rope speed of 300 feet a minute.

With the sorting done, the ore is delivered to an aerial tramway 3 miles long. The system is supported by structural-steel towers spaced 250 to 1000 feet apart and transports 0.8 ton per bucket, or a maximum of 50 tons an hour. Loaded buckets are carried by a 1¼-inch cable, while the empty-bucket line has a diameter of ⅞ inch. At the discharge end of the tramway is a narrow-gauge railroad which delivers the raw product direct to bins at a smelting plant in Santa Rosalia.

Before the ore goes to the reverberatory furnaces it is reduced in size to 2-inch mesh by a hammer crusher which is fed right from the bins. This is followed by drying in a rotary kiln drier, after which pyrite, coal, and limestone are added to the material. In smelting, the coal serves as the reducing agent for the oxides, and the pyrite gives up sulphur to combine with the copper to form copper sulphide. This goes into the matte, which is converted into a product that runs 99.2 percent copper. The limestone for the operation is mined within 3 or 4 miles of the outskirts of the city of Santa Rosalia, and the pyrite comes from British Columbia. The copper, itself, is shipped by boat to a smelter in Tacoma, Wash.

Since 1895, or within an active period of approximately 60 years, this Cia. del Boleo enterprise has produced 10,000 tons of copper a year. Now the final chapter of the undertaking is being written. The boats are being sold, as will be the smelter, mine surface plants, etc., when the day of shutdown arrives. Then Santa Rosalia may once again experience a drastic drop in population and perhaps join those worked-out mine areas that have become known as ghost camps.

A. Nopper, general manager, and Pierre Mahieux, assistant general manager, are directing the operations of the company.

Modern Electroalchemy

W. M. Goodwin

AFTER the industrial revolution it was, for a long time, an axiom that it takes a great coal field to produce a great industrial area. In most parts of the world coal spells power, and abundant and cheap power is the mainstay of industry.

Eastern Canada is an exception to this rule. Ontario and Quebec have no coal, but they have a big and growing industry. This is based not upon coal but upon an abundant supply of low-cost hydroelectric energy. Where Nature has been niggardly in providing fuel, she has been exceedingly generous in bestowing a source of power that will last forever.

It was at the turn of the last century that Canadians began to take an interest in their large waterpower resources. The first developments at Niagara Falls furnished energy at rates before undreamed of, and this soon attracted some of the early electrometallurgical industries. Other enterprises followed quickly, and when the first World War came along the Dominion was able to supply an appreciable share of the munitions of war with the aid of her hydroelectric power. By the time of World War II the power systems and their products in Ontario and Quebec had multiplied many fold, and once again they were geared to the war machine and produced mightily. In fact, without this abundance of power, Canada's outflow of munitions would have been a mere trickle, compared with the

"WHITE COAL" AND WHITE METAL

One of the outstanding wartime construction jobs was the secret erection of the huge Shipshaw power development on the Saguenay River to produce additional electrical energy for the Arvida plant of the Aluminum Company of Canada. Shipshaw Powerhouse No. 2 (top-center) generates 1,200,000 hp., which is available throughout the year. An interior view of the station, which contains twelve 100,000-hp. generators, is at the top-left. Shown just above are ingots of aluminum stacked for shipment in the Arvida smelter, where the daily capacity in 1944 reached 3,000,000 pounds. When the war ended, one-sixth of all the electric power generated in Canada was being used for the production of aluminum.

CARBIDE PLANT
This establishment of Shawinigan Chemicals Limited at Shawinigan Falls started before World War I to make calcium carbide, which was used to generate gas for domestic lighting and for miners' lamps. In 1915-16 it began the production of acetone from acetylene by a German process. The acetone was used in the manufacture of the explosive cordite. During the recent conflict, the plant turned out the superexplosive RDX and many other products from calcium carbide. Virtually all North America's supply of "flints" for cigarette lighters is made here. The sparking element is cerium, one of the "rare-earth" minerals. It is combined with iron to form cerium ferrocite.

mighty stream that actually reached the battlefields of the world.

In the following pages will be given an outline not of the whole of eastern Canada's great power-consuming establishments but of only certain plants along the St. Lawrence and its tributaries that provide basic products for industry, all of which were turned to war use and were essential to the making of munitions. This capacity to expand and to diversify the output of such products constitutes one of the Dominion's main industrial opportunities today. So what has been accomplished to meet the needs of war may be a guide to what can be done to supply the markets of peace.

Dominion Magnesium Limited, whose plant is the most westerly of those to be considered, is a "war baby" that promises to have a useful adult life. It was placed out in the country at Haley, Ont., because of a plentiful local source of the magnesium-bearing rock dolomite and of low-cost power from a site close by on the Ottawa River that had recently been harnessed. Another reason was the nearness to Ottawa where the research that had resulted in the works was still being conducted by Dr. Lloyd M. Pigeon in the National Research Laboratories.

The Pigeon process is based on the thermal reduction of calcined dolomite under vacuum. While dolomite is not the richest magnesium-bearing rock, it is one in which the remaining ingredients are such that they neither interfere with distillation nor give the metal impurities. The metal produced by Dominion Magnesium ranks with the cheapest made and has the distinction of being of the highest purity. This quality has a very important bearing on many of the uses of magnesium.

The operating cycle is a very simple one. Dolomite from the company's open pit is crushed to minus ¾ inch, calcined in a rotary kiln, and the finely ground material is mixed with a suitable proportion of ferrosilicon and then briquetted. The briquettes are heated in cylindrical metal retorts horizontally disposed in electrically heated furnaces. The latter are maintained at a temperature of 2138°F. under an extremely high vacuum, and one end of each retort projects beyond the furnace and is water-cooled. The ferrosilicon takes the oxygen away from the magnesium oxide of the calcined dolomite, and the volatile magnesium metal is condensed as "crowns" in the cool end. The crowns are melted and cast into ingots, billets, slabs, or sticks, with or without alloying metals.

The Pigeon process was owned in 1941 by a private company which was preparing to erect a small plant. When urgent need suddenly arose for a large quantity of magnesium for airplane construction, the Canadian Government found that the method offered the surest means of getting it in the shortest possible time. By agreement with the concern, a plant with a daily estimated capacity of 10 tons was erected with all practicable speed. Within six months the first metal was produced. Soon the rated capacity was reached, and when the establishment was purchased by the company from the government in 1945 the output was 16 tons a day. Only a small percentage of the magnesium was used in Canada, the bulk of it went to Great Britain. Substantial shipments also were made to Russia.

In normal times, the works of Domin-

ion Magnesium would not have been erected until the pilot-plant tests had proved such a course to be warranted. As it was, the full-scale plant, put up directly following the laboratory experiments, operated with exceptional smoothness. Nevertheless it was found that a good many changes were required to get maximum efficiency. These are now being made preparatory to what the company expects will be a long career in furnishing high-purity magnesium to light-metal manufacturers throughout the world.

Near the old French-Canadian town of Beauharnois on the St. Lawrence River, just beneath the rock-rimmed escarpment over which the water from the diversionary canal falls to provide power, there is an ideal site for the production of ferrosilicon. The rock of this escarpment is sandstone of a quality well suited for the reduction process. A quarry has been opened that yields the raw material at exceptionally low cost. From the nearby factories of Montreal and vicinity is obtained an ample supply of steel turnings. Coke and coal for reduction are obtained economically, and electric energy is delivered from the adjacent power plant at a minimum rate. Rail connections are good, and lake vessels can dock and transport to overseas markets from the port of Montreal.

St. Lawrence Metals & Alloys was set up in 1936 by Robert Turnbull, one of the pioneers of Canadian electrometallurgy, specifically to take advantage of the resources just mentioned and mainly to serve foreign trade. When the war started in 1939 there were seven furnaces in operation consuming 32,000 kw. of electrical energy and yielding daily 35 tons of ferrosilicon and silicon metal. The wartime demand more than doubled production and diversified it somewhat, so that now there are thirteen furnaces that use 64,000 kw. for an output of 70 to 75 tons of ferroproducts a day.

It has been found that electric furnaces of moderate size are the most economical type for the manufacture of ferrosilicon. However, the input of electrical energy is much greater than it is in the case of all other electroproducts except aluminum, so that a furnace requiring 7000 kw. is about 15 feet across the hearth. The plant regularly makes ferrosilicon of 50 and 75 percent silicon content, as well as silicon metal of 98 percent purity.

An interesting wartime yield has been calcium silicide for smoke bombs. This is produced in one of the regular furnaces by adding lime or limestone to the charge to provide the required proportion of calcium. A special plant was erected to prepare the material, which is called calcium-silicon in the alloys trade. Today it is serving to an increasing extent as a powerful deoxidizer for certain iron and steel products. Thus, as in so many other instances, wartime development may remain as a useful adjunct to peacetime pursuits.

While almost every iron and steel plant in the Dominion consumes at least a small amount of ferrosilicon or silicon metal, the principal single customer of St. Lawrence Metals & Alloys during the latter years of the conflict was Dominion Magnesium. As has already been noted, it is ferrosilicon—the 75 percent grade—that is used to obtain the metallic magnesium from the magnesium oxide of the dolomite rock. The total Canadian market for ferrosilicon and silicon is small, however, compared with the capacity of St. Lawrence Metals & Alloys, and the firm will continue to sell the larger part of its output overseas.

A great diversity of products is made in the plants of Shawinigan Chemicals Limited at Shawinigan Falls, Que., and all are derived from calcium carbide. Before World War I this was the company's only product, and it was used largely for domestic lighting and for miners' lamps. At that time the concern was known as Canada Carbide Company.

In 1915-16 a group of young Canadian chemists and engineers, with only the data in some German patent applications to guide them (and some of that information was misleading), succeeded in the incredibly short time of nine months in devising a series of workable processes that resulted in carload-lot shipments of acetone obtained from acetylene gas. This was one of the feats that saved the day for Britain and some of her Allies, who had previously been largely dependent upon Germany for the acetone used in the manufacture of their chief propulsive explosive, cordite. These methods were perfected between wars, and many other acetylene derivatives have been made available to the chemical industry by additional processes.

In 1939, Shawinigan Chemicals, among other companies in Canada, was called upon immediately to supply the chemical sinews of war. Among these might be mentioned monoethylaniline (a stabilizer for cordite), butyl alcohol, acetic acid, vinyl resins, acetylene black, and small amounts of a number of unusual products required for war research, which was conducted on an experimental scale in the company's laboratories. But of Shawinigan's contributions, probably the outstanding one was its share in the development of the superexplosive known as RDX. After test and pilot-plant work had been completed in a matter of three or four months, the Canadian Government authorized Defence Industries Limited to construct a plant that was operated by Shawinigan Chemicals until the close of hostilities. The production record of this establishment is one of the epics of the Canadian war effort.

When Norway was invaded by the Germans, Great Britain's normal supply of calcium carbide for cutting and welding metals was discontinued. There was no help to be had from the United States, where huge shipyard demands had caused an acute carbide shortage. Canada was urged to take up the slack, and the building of a new 20,000-kw. closed furnace at Shawinigan was ordered in 1941 by the Department of Munitions & Supply in Ottawa. As the need for carbide in Canada increased, another similar furnace was authorized in 1942, bringing the total capacity of the works to about 250,000 tons

ST. LAWRENCE METALS AND ALLOYS LTD.

Sandstone obtained from a nearby quarry is reduced in this plant to ferrosilicon and silicon metal of 98 percent purity. During the war, its production was doubled and it turned out 70-75 tons of materials daily. Its thirteen electric furnaces utilize current from the adjacent Beauharnois power development on the St. Lawrence River. Most of its principal product, ferrosilicon, is used by Dominion Magnesium Limited in the manufacture of magnesium.

DOMINION MAGNESIUM LTD. Situated at Haley, Ont., this plant uses Ottawa River hydroelectric power for the thermal reduction of dolomite by the Pigeon process. It produces up to 16 tons of high-purity magnesium metal daily. In the interior view of the reduction-furnace building (below) the round, water-cooled ends of the retorts may be seen projecting from the long banks of furnaces on both sides of the room. The trucks in the aisle contain paper bags of the raw material—a briquetted mixture of calcined dolomite, ferrosilicon, and fluxes—that is charged into the retorts.

a year. Furthermore, the parts of three carbide furnaces were fabricated and shipped to England for assembly, together with technicians and a crew to start up the installation and to see it through to smooth operation. Already, additional plants to serve peacetime requirements are under construction at Shawinigan Falls, and it is very likely that other projects will be attracted to the region by the low-cost power available there and at the nearby St. Lawrence ports.

The most spectacular wartime enterprise in Canada was the development of the aluminum industry. In 1939, both production and fabrication were already firmly established—in fact, the largest single smelting plant in existence had but lately been built at Arvida on the Saguenay River. The sudden demand (largely from Great Britain) in 1940 necessitated an immediate and substantial increase in output. Heroic measures were taken, and the 1939 smelting capacity of 440,000 pounds of metal a day reached 3,000,000 pounds daily by 1944. This sevenfold increase in such a short time was possible only because a large percentage of the essential electric power was available, and the remaining 1,200,000 hp. could be obtained rapidly by completing the plan already underway on the Saguenay. When the war came to an end, the aluminum industry alone was using one-sixth of all the power that was being consumed in Canada.

The first aluminum plant in Canada, and one of the first in the world, was established in 1900 at Shawinigan Falls on the St. Maurice River. As has been mentioned previously, aluminum requires more electrical energy for reduction than any other common electroproduct. Therefore, it is of prime importance to have low-cost power and that the reduction works be as close as practicable to the generators. At Shawinigan the pot-lines are within a few hundred feet of them so that the cost of transforming the power is eliminated and that of transmission is cut to a minimum.

As has happened so often in Canada, it was the vision of an American, J. B. Duke, that gave rise to the vast project on the Saguenay. Latterly, the enterprise has been controlled by the Aluminum Company of Canada, and the town of "Arvi-da" was named after Arthur Vining Davis whose initiative succeeded that of Mr. Duke. These men saw clearly that the Saguenay's 2,000,000 hp. would be needed some day to provide aluminum for the world's markets; but they could not foresee the industry's extremely rapid development caused by a world war fought so largely in the air.

Wartime expansion was effected mainly by adding new pot-lines to the existing establishments at Arvida and Shawinigan Falls. Nonessential civilian consumption of electricity was curtailed drastically, and all standby generating units were finally put to steady use. Pot-lines were also built close to the large power plants at LaTuque on the St. Maurice and at Beauharnois on the St. Lawrence, and as fast as they were installed there was a proportionate increase in the output of aluminum. The industry's production plans, however, considerably exceeded the capacity of the existing hydroelectric stations. Work was started in 1941 on the great Shipshaw No. 2 canal and power plant, and by the end of 1942 the first of the giant 100,000-hp. units was in action. A year later all twelve were available, and the station was in a position to furnish 1,200,000 hp. of electrical energy. Surely, this was a great engineering feat and one that has not been surpassed except, perhaps, in the actual theater of war in Europe.

Enlargement of the aluminum reduction works of course involved a corresponding sevenfold increase in all the auxiliaries feeding them. The bauxite mines in British Guiana, the fluorite mine in Newfoundland, the steamship lines, the docking facilities at both ends, the ore plant for purification of the bauxite at Arvida, the special railway cars for transportation of the refined alumina to the scattered pot-lines—all these and many more things essential to the complete plan had to be expanded.

This outline covers only some of the outstanding projects in the wartime electrometallurgy of eastern Canada. There were some splendid achievements farther west in Ontario, Alberta and British Columbia, but enough has been set forth to illustrate the prime importance to the Dominion of her abundant, low-cost, year-round hydroelectric power and some of the means by which the metallurgist and the chemist have put it to use.

Doing It with Air

BORING UNDER PAVEMENT

First a trench is dug down to the level at which the pipe is to be run. Then a workman lines up the drill pipe with the desired path by means of a gunbarrel-like sight mounted on the boring mechanism (above). Boring is done with a fishtail bit (right) screwed onto the end of the pipe. Power is imparted at the opposite end of the pipe by a "multi-vane" air drill (upper right). Water under 100 pounds pressure is introduced to wash away the cuttings.

THE Southern Counties Gas Company of California, which serves Los Angeles and the surrounding area, is distinctly air-conscious, as the accompanying pictures show. The operation and maintenance of a gas-distribution system involves a lot of construction work that has traditionally called for much tiring muscular effort. Progressive companies have gradually found ways to mechanize many of the operations, but none has gone farther in this respect than the Pacific Coast concern. To quote its viewpoint, as expressed in its employee publication, "A dozen men straining every muscle at a back-breaking job was the old way; half that many easily and pleasantly accomplishing the same task is the new."

The company's engineering department developed the methods illustrated. In each instance it first made a careful study and consulted the men who actually do the work to obtain their suggestions. All the improved ways of doing certain jobs utilize air power. That was to be expected, because gas companies have long employed portable air compressors and complementary tools for constructing and servicing distribution lines. Under the circumstances, it was the natural and economical course to take further advantage of the equipment at hand. In most cases it has been possible to make fuller use of tools that were already available, and it has consequently not been necessary to add many new ones.

One of the perplexing problems has always been the laying of pipes under and across paved streets and highways. The old method was to dig a trench, which obviously involved tearing up the pavement. This was not only costly and time-consuming but also presented a traffic hazard. Various attempts have been made to obviate trenching by devising means of boring beneath the pavement while leaving the surface undisturbed. Until recently, Southern Counties' crews accomplished this in a limited way by battering-ram tactics. A group of men forced an opening through the earth by repetitive jabbing with a long pipe carrying a bit on its piercing end. That was heavy work and was effective for distances of only 25 or 30 feet. Moreover, it was difficult to maintain the line desired.

A new method, which is now being put in service in all districts where the company operates, permits boring up to 100 feet with speed and accuracy and with virtually no physical effort. The pipe is tipped with a fishtail-type bit and is rapidly revolved by a compressed-air motor while water under 100 pounds pressure is introduced to wash away the cuttings. Additional pipe lengths are screwed on as required, just as is done in drilling a vertical oil or water well. The entire

operation can be completed in a few minutes. Attached to the boring apparatus is a sighting device which makes it possible to line up the hole accurately before boring is started.

Another new practice eliminates the necessity of digging up and replacing steel pipe that has become corroded after long use. Instead of putting in new piping, smaller-diameter copper pipe is run through the existing conduit without disturbing it. This was formerly done to a limited extent by forcing the smaller pipe through the larger one by brute force. Now pulleys and cables are suitably arranged, and the power required is obtained from a compressed-air hoist. By digging a trench only 30 feet long sufficient working room is provided, and it has been found practicable to run as much as 1000 feet of the copper pipe into straight sections—sections without sharp curves or angles. The same air hoist that helps to insert the pipe also serves, through the medium of a boom and pulley, to pull a scraper that is used in backfilling excavations.

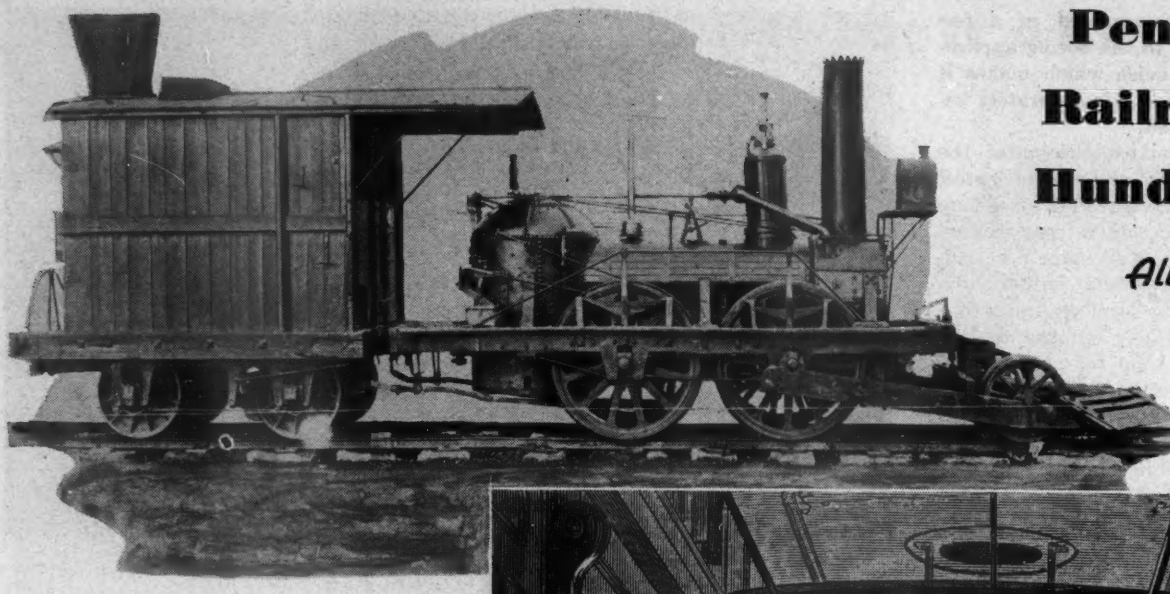
BACKFILLING AN EXCAVATION

By attaching a pulley to the end of a boom mounted on the front of the truck, the Utility hoist is used to pull a simple scraper for moving dirt back into a ground opening. The boom is carried on the truck and set up when needed.

In working out the pipe-reconditioning system, the engineers ran into trouble in the form of welding burrs projecting into the steel pipe at some of the joints. These hard snags stopped the progress of the copper pipe and necessitated opening up a trench at the point of obstruction and removing the joint concerned. The difficulty was overcome by devising an air-operated reamer that rotates at around 2000 rpm. and quickly removes the burrs, leaving clean wall surfaces that offer a minimum of friction to the passage of the pipe. This method was introduced last year in Orange County and was used on approximately 4 miles of old gas mains. It is now being applied to the remainder of the system.

RELINING OLD MAINS

Steel gas mains that became leaky through corrosion were formerly dug up and replaced. Now slightly smaller copper piping is run inside the old pipe. By the first method used it was driven through by hand, a laborious job that gave uncertain results. The latest practice is to hook a block-and-cable assembly to the copper tubing and to pull it through the larger conduit with power from a single-drum Utility hoist conveniently mounted on the front of a truck, as shown in the center view. By opening up about 30 feet of trench, sufficient working room is provided to introduce up to 1000 feet of pipe if no sharp bends are to be negotiated.



Pennsylvani
Railroad Ma
Hundredth Y

Allen S. Park

THE Pennsylvania Railroad, one of the nation's leading transportation systems, completed 100 years of existence on April 13. From an initial link extending 60 miles between Harrisburg and Lewistown, Pa., with a daily passenger train and two freight trains a week, it has grown to a network of 9750 miles in thirteen eastern states and the District of Columbia.

Incorporated by an act of the Pennsylvania State Legislature on April 13, 1846, it was issued a charter soon afterward authorizing it to build a railroad from Harrisburg to Pittsburgh, a distance of 249 miles. It came into being at the behest of leading Philadelphia businessmen, who sought to recapture trade that was getting away from them. Until 1825, Philadelphia was the commercial and financial center of the country, but it lost ground with the completion of the Erie Canal to the north and of a competing railway to the south. The remedy appeared to be a railroad across Pennsylvania to connect with other lines that were opening up frontiers in the growing West.

The state already had a system of connecting railroads and canals from Philadelphia to Pittsburgh, but it was too complicated to render effective service. That was the Main Line of Public Works, upon which construction was started in 1823. It consisted of an 81-mile railroad from Philadelphia to Columbia; 173 miles of canals from Columbia to Hollidaysburg, comprising the Eastern and Juniata divisions of the Pennsylvania Canal; the 36-mile Allegheny Portage Railroad between Hollidaysburg and Johnstown, with five inclined planes to negotiate the mountain slopes; and the 105-mile Western Division of the Pennsylvania Canal from Johnstown to Pittsburgh. The total route length of the transportation network was 395 miles. The state also owned a system of branch canals. The most important of these were the Susquehanna Division from Duncan's Island (north of Harrisburg) to Northumberland, 39 miles; the West Branch Division, Northumberland to Farrandsville, 72 miles; the North Branch Division, Northumberland to Lackawanna Creek (near Wilkes-Barre), 72 miles; the Delaware Division, Bristol to Easton, 60 miles; and the Erie Extension, from near New Castle to Erie, 106 miles.

The legislative act creating the railroad gave the president and the board of directors authority to determine the most advantageous route to be followed and also empowered them to build a branch to Erie on the Great Lakes and other branches into counties traversed by the Main Line. The stockholders elected directors on March 30, 1847, and on the following day the latter elected as the road's first president Samuel Vaughan Merrick, a

Philadelphia civic and business leader.

J. Edgar Thomson, the line's first chief engineer, estimated that the cost of constructing the railroad and purchasing the locomotives and cars initially required would be $11,140,000, a large sum in those days. But by means of a temporary co-operative service arrangement with the state's transportation system the outlay was reduced to $7,860,000. Subscriptions for the capital stock of the road amounting to $5,500,000 were made up to the end of 1849. The shares sold for $50, payable in ten installments of $5 each.

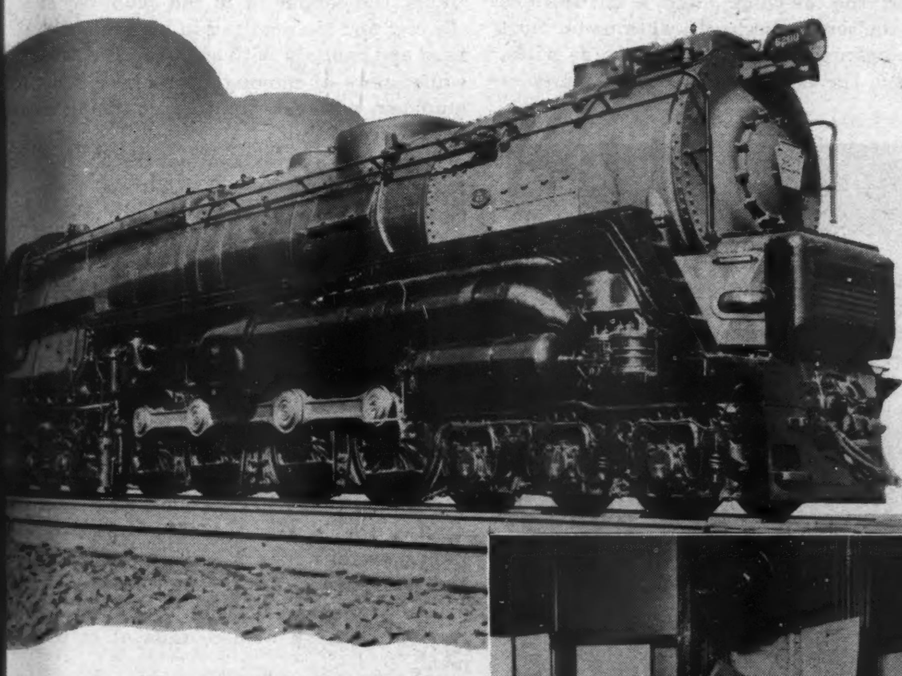
The first 60-mile section of track from Harrisburg to Lewistown was completed on September 1, 1849, so actual service on the Pennsylvania Railroad can be dated from that day. By 1850 the line was in operation as far west as Altoona, now the terminus of the Eastern Division. Four years later, the tracks had reached Pittsburgh. In 1857 the Pennsylvania bought the section from Philadelphia to Harrisburg, which had been constructed prior to its organization.

Meanwhile, Mr. Thomson had been elected president, and he urged upon the directors the wisdom of extending financial assistance to railroads being built by other interests in Ohio and Indiana. Once these were completed, he argued, the Pennsylvania could link up its own system with them and thus give service from the Atlantic Seaboard to areas that were eager for development. This early policy shaped the pattern for the Pennsylvania Railroad.

Within fifteen years after its founding, the highway of iron (steel was yet to come) reached from the Atlantic to Chicago, and not long thereafter to St. Louis. By 1873 the eastern end of the network had been carried to Jersey City, from which ferry connection was maintained with New York until the tunnels now used were constructed underneath the Hudson River. In the interim Washington had been linked with the system, first by a route from Harrisburg via Baltimore, and afterward by a direct line from Philadelphia through Baltimore. In the West, extensions were made to Peoria, Ill., in 1893; to Buffalo, N.Y., in 1900; and to Detroit, Mich., in 1920.

By 1902 electrification was begun first of parts of the subsidiary Long Island Rail Road and later of the suburban lines radiating from Philadelphia. Experience on these sections demonstrated the advantages of electric service on trackage carrying very heavy traffic. Today, the Pennsylvania System is completely electrified for 194 miles between New York and Harrisburg and for 226 miles between New York and Washington. Much of this mileage affords a 4-track right of way, constituting the busiest stretch of railroad in the country. Total trackage in electrified zones is 2600 miles.

Throughout its history, the Pennsylvania has been a pioneer in research and has developed and applied many of the fundamental improvements, processes, and operating methods by which the science of railroading has advanced. It was the first to adopt the air brake, a 6-car train having been provided with



MILESTONES IN PROGRESS

The "John Bull" (top-left) made in England, was the first locomotive used in America. It weighed 10 tons and had a top speed of 15 miles an hour. It ran on the Camden & Amboy Railroad, later incorporated in the Pennsylvania system. When the sleeping car shown at the left went into service between New York and Chicago in 1875 it was the finest of its kind, save for one owned by the Pasha of Egypt. Its appointments included "elegantly carved columns of burnished silver," and "silver-plated globe lights." The newest "iron horse" on the line is the 6900-hp., steam-turbine-driven locomotive pictured above. First of its kind, it travels 100 miles an hour with ease and weighs about 500 tons.

THE TRAIN TELEPHONE

A 2-way electronic telephone system that permits continuous conversation with moving trains, between trains, and between the head and rear ends of trains has been successfully used for more than two years on a 50-mile stretch between Trenton and Phillipsburg, N. J. It operates with carrier current that is fed conductively into the rails and picked up inductively from them by the wires of the communication line adjacent to the tracks. The picture below shows W. P. Bird (left), block operator at Frenchtown, N. J., talking with Engineman Frank Scheidecker on a freight train miles away. This system is now being installed on the Pennsylvania's main line between Harrisburg and Pittsburgh.

George Westinghouse's revolutionary safety device in September, 1869. This train traveled from Pittsburgh to Altoona over heavy grades controlled solely by air brakes. In November of the same year a 10-car train was similarly equipped and run to Philadelphia to demonstrate the effectiveness of the new braking system to the directors of the road.

The Pennsylvania also claims to have been the first to employ steel rails, steel cars, and block signals; to apply the telephone to railroading; to operate through freight trains on regular schedules; and to coördinate truck and train freight service. It has recently instituted the use of telephones on moving trains, and its latest innovation is the introduction of the direct-drive steam-turbine locomotive. The line was the second in the nation to utilize pneumatic tie tampers for consolidating track ballast, this service dating from about 1914. It employs air power extensively in building and maintaining track and structures, and is a leading exponent of the application of pneumatic tools in the construction and repair work carried on in its locomotive and car shops.

The telephone system just mentioned provides a means of continuous communication between trains and wayside towers, between the head and rear ends of moving freights, and between different trains. It has been in experimental service on a 50-mile stretch of the Pennsylvania between Trenton and Phillipsburg, N. J., since June, 1942. As a result of its success there, it is now being applied to main-line operation on the 245-mile Harrisburg-Pittsburgh section. Approximately 300 passenger and freight locomotives, 90 freight-train cabin cars, and six strategically located wayside stations are being equipped.

The system has been developed through joint research by the railroad, the Union Switch & Signal Company, and General Electric Company. Actually, it is a combination of certain features of radio and telephone. Radio would, perhaps, be a satisfactory medium of communication except for the fact that it would have to use air lanes that are already fairly crowded. Even if Federal sanction to do this could be obtained, considerable confusion would inevitably result. On the other hand, the telephone alone is not suitable for the service because transmission must be confined to fixed paths such as wires. Hence the decision to utilize features of both mediums. This makes it possible to maintain the constant contact with moving trains that radio affords and also to restrict the transmission paths to railroad property.

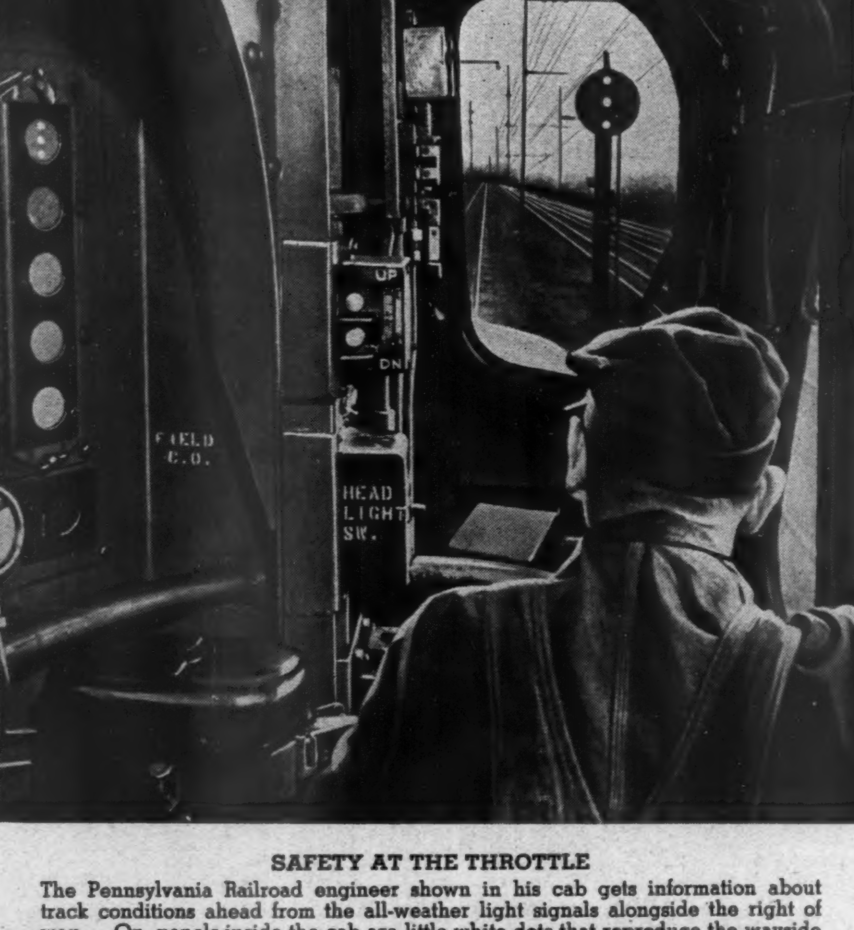
By the combination system, carrier current is fed conductively into the rails and induced in the wires of the existing line of communication adjacent to the track. On the locomotives and in the cabin cars are loops, close to the rails, by which the energy is fed or picked up with electronic aids. At the receiving end it is amplified and demodulated before going to loudspeakers and hand-set telephones. Towermen in wayside towers can thus give verbal instructions, reports, and pertinent information to crews on trains many miles away. Similarly, the trainmen can keep the towerman fully informed as to their movements and can immediately let him know if something has happened that may delay their schedules. The towerman in turn, can then notify the dispatcher so that he can promptly plan all train movements. On freight trains, the conductor in the cabin car at the rear and the engineer in his cab at the head end can talk with each other at will, while crews of moving trains may communicate with one another at distances up to several miles.

During its first sixteen months of operation, the Pennsylvania Railroad Company's total revenues came to only $339,000. Last year its gross income was $979,444,033, and in two war years it was even higher. The road's total assets now exceed two billion dollars owned by 214,995 stockholders. A cash dividend has been paid annually since 1847, aggregate payments amounting to $1,297,893,025. Bondholders have received more than a billion dollars, and employees' wages have exceeded ten billion dollars.

Entering 1946 and its second century of service, the line had 4848 locomotives, 7299 passenger cars, 240,293 freight cars, and 5614 pieces of work equipment. Its marine department, including boats and barges, consisted of 378 units of equipment.

Last year the road hauled more than 280 million tons of freight, for which it received a revenue equivalent to less than a cent per ton per mile. It transported in excess of 159 million passengers, and its return from each was a small fraction more than two cents per mile. Its varied functions in serving the most populous and most industrialized region in the country were carried on by 160,000 employees.

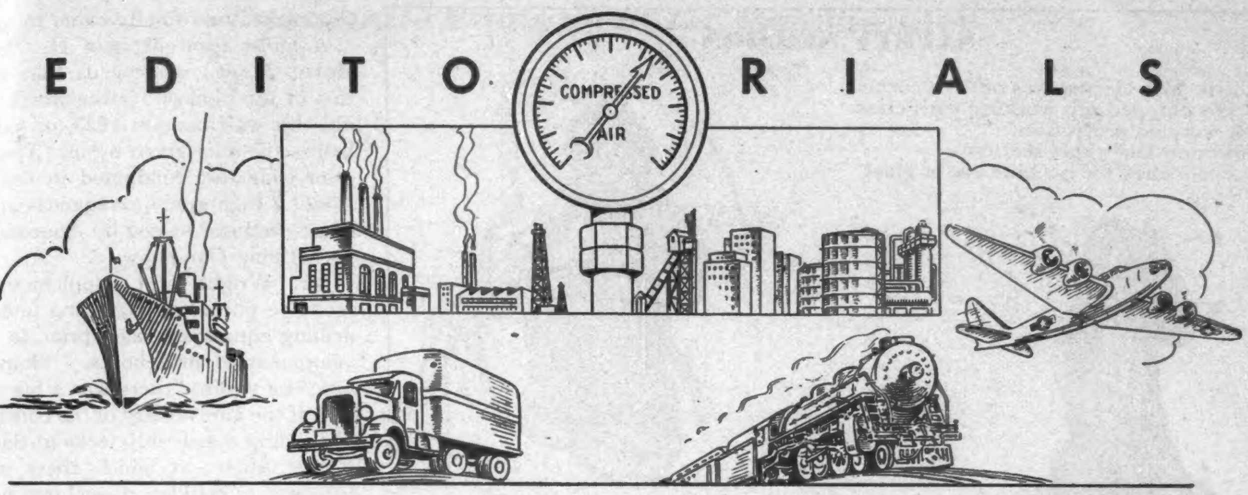
With a view to improving equipment and facilities, the company has conducted a research and testing department since 1874. The present testing activities, centered at Altoona, Pa., call for the services of 275 men and cost $1,500,000 annually. The staff includes mechanical, electrical, and civil engineers, chemists, and forestry specialists.



SAFETY AT THE THROTTLE

The Pennsylvania Railroad engineer shown in his cab gets information about track conditions ahead from the all-weather light signals alongside the right of way. On panels inside the cab are little white dots that reproduce the wayside signals in miniature, thus insuring safety regardless of outside visibility.

EDITORIALS



CAPITAL AND CONSUMER GOODS

IN ANY consideration of prices and their relation to inflation and the future national welfare a distinction should be made between consumer goods and capital goods. In general, individuals buy consumer goods and organizations buy capital goods. There is a vast difference in the spending habits of these two groups. At present, individuals, flush with money and unable to purchase refrigerators, automobiles, vacuum cleaners, and other durable things, are spending freely for amusements and whatever merchandise the stores afford. In most cases, they are paying relatively high prices for what they get, but they don't seem too much concerned about that.

The rate of individual savings, as measured by the sales of Series E Government Bonds, has dropped to one-half its wartime pace. These are the forces that make for inflation: plenty of money and a scarcity of consumer goods. Under such conditions, there can be little sound argument against the wisdom of some measure of price control. The only question is how to apply it so that it will not stifle free competition, the factor that has always brought prices down to a reasonable level and kept them there.

In the field of capital goods, the situation is entirely different. Whoever heard of a power company buying an additional generator or of a mining company buying more rock drills just because it had plenty of idle funds in the treasury? Industries, large and small, purchase new equipment only when it promises to reduce operating costs. In short, they expect it to pay for itself and to yield a profit besides. And, before they buy it, they must feel pretty certain that it will do those things. Obviously, then, industrial machinery cannot be sold if its cost is too great to benefit the purchaser.

A different economic pattern applies to dealings in capital goods than to those in consumer goods. The latter are ordinarily purchased out of income or savings and represent an immediate drain upon the buyer's resources. If you get a suit of clothes, you reduce your bank account by the amount spent for it. On the other hand, when an industrial concern purchases new machinery, it distributes the cost over a long period of years through depreciation and does not feel a sudden financial impact. Before the equipment wears out, it more than pays for itself through the reduction in production costs it makes possible.

As a matter of fact, the effective use of labor-saving and cost-reducing machinery constitutes one of the most potent weapons against inflation, for it offers manufacturers just about the only opportunity they have today of cutting the selling price of the products they make. This is the message that the machine-tool builders have been putting before Congress and the people for several months. The arguments they present apply with equal force to other branches of the machinery industry. Manufacturers know that for some time to come they cannot expect lower wages or lower taxes or lower prices for their raw materials than they are paying now. The one avenue open to them is to multiply the productivity of the individual worker through the utilization of new and better machinery.

A high level of production of everything we use is conceded to be one of the greatest needs of postwar America. If everyone who wants to work can be kept employed there will be sufficient purchasing power to absorb the goods made, and competition will soon adjust prices to a reasonable level. Experience has shown that as the use of machinery grows, better products become available to more people, over-all employment increases, and the standard of living is raised.

Industrialists are not the only ones who are thinking along these lines. In a recent article in the *Saturday Review of Literature*, Judge Jerome Frank of the U. S. Circuit Court of Appeals wrote: "As millions of men, for a long time to come, will have extensive unsatisfied economic wants, labor-saving machines, under adequate guidance, need not spell widespread unemployment. As machines grow more efficient, the number of hours of labor per man will grow increasingly fewer, so that living standards can rise while the hours of labor required for economic purposes can be reduced. It is sinful today not to promote actively the coming age of plenty. It is sinful to do anything which blocks the advent of that age. In America it is sinful to impede the employment of our industrial equipment and our industrial knowledge."

A WORTHY FOE OF FIRE

MANY a worth-while and important organization labors in the public interest without fanfare or hullabaloo. Such a body is the National Fire Protection Association, which will observe its fiftieth anniversary at its headquarters in Boston during the first week in June. It is a clearing house of information on fire protection and fire prevention. It has served the industrial world capably and faithfully. It is run without profit with funds contributed by more than 150 national organizations and 10,000 individuals.

A major activity of the association is the production of comprehensive popular and technical literature dealing with fire control. It distributes from five to ten million copies of its publications annually, and these range from factory payroll leaflets warning workers about fire to 1000-page volumes. Since 1923 it has maintained a paid field staff to provide direct contact with state, provincial, and municipal governments in the United States and Canada for the purpose of stimulating good fire-control practices. It inaugurated Fire Prevention Day on October 9, 1916, and this has since been changed to Fire Prevention Week, during which the chief annual campaign against fire is conducted in the United States and Canada. The week always includes October 9, the anniversary of the historic Chicago fire of 1871. Since 1933, the association has published a magazine, *Firemen*, which is designed especially for small communities that are served by volunteer fire departments. More than 20,000 volunteer firemen are now affiliated with the organization.

SAFETY SERMON

Little Jack Horner was off in a corner,
His chipper gun working with class.
He wore no protection,
And now the whole section,
Feels sorry for his blue eye of glass.

This Little Horner obeyed the rules,
He wore his goggles while workin'
His first name is Bob,
And he's still on the job,
With eyes to see what's cookin'.

Anniversary-Issue Echoes

AS AN aftermath of our Fiftieth Anniversary Issue, which appeared in March, we have received communications regarding several matters that were discussed in it.

From T. H. Proske of Denver, Colo., has come an early catalogue describing the Ajax drill sharpener that he developed in 1902 and manufactured for some years thereafter. A letter accompanying it amplified the information presented by us on the history of this type of equipment. J. George Leyner, also of Denver, worked on a mechanical sharpener in 1902, but laid it aside for more pressing matters until 1907. Meanwhile, Mr. Proske was selling his sharpener to mines in various parts of the world, and he apparently merits the distinction of having brought out the first commercial machine in this field. Mr. Proske writes:

"I developed the first power drill sharpener at the Portland Mine in Cripple Creek, Colo. Soon afterward, I put one in at the nearby Ajax Mine and thereupon adopted the name Ajax for the machine. I had expected to receive financial aid from the master mechanic of the mine, but this was not forthcoming and I had to go it alone. A little later I put a sharpener in at the United Verde Mine at Jerome, Ariz., and this was followed by others at the Standard Mine at Wallace, Idaho, the Alaska Treadwell Mine in Alaska, and the Homestake Mine at Lead, S.D. W. L. Saunders of the Ingersoll-Sergeant Drill Company saw the sharpener while visiting the Homestake property and went from there to Denver, where he asked Thomas B. Stearns of the Stearns-Roger Manufacturing Company to go with him to the McFarlane Manufacturing Company, which was making the sharpeners for me. He met me there and asked me to go to the theater with him that evening, which I did. Afterward we retired to the Brown Palace Hotel and there entered into an agreement whereby the Ingersoll-Sergeant Company was to act as my sales agent. The company and its successor, Ingersoll-Rand Company, thereafter sold the Ajax sharpener to mines in many parts of the world.

"In 1909, I went to Buhr, Germany, to demonstrate a sharpener at a government-operated mine. Prior to that time, only Z bits, forged by hand, were in use there, but when the Ajax went into operation, X bits were adopted. Cross bits were used in driving the Loetschberg Tunnel and their success there led to their general application in European mining and tunneling operations.

"When Ingersoll-Rand absorbed the Leyner interests in 1912, it obtained his sharpener. This was designed to make and sharpen bits on hollow drill steel, which was then coming into increasing use. As the Ajax was designed primarily for putting bits on solid steel, its sales gradually diminished and finally came to an end."

A letter from Morgan H. Wright of Butte, Mont., informs us that the first test of the pioneer Hawkesworth detachable bit was made in 1923, or four years before the date given by us. That was a mine-wide test conducted in the Emma Mine, a high-grade manganese and zinc-silver producer owned by Anaconda Copper Mining Company.

Mr. Wright also supplemented the facts we published regarding underwater drilling equipment used prior to the development of drill boats. "Some years ago," he wrote, "there was a big celebration of the anniversary of the construction of the first steam ship locks at Sault Ste. Marie, Mich., at which there was distributed a booklet describing how the work was done. It mentioned the failure of the U. S. Army Engineers either to build successful cofferdams or to excavate submerged reefs. The Fairbanks Company was awarded a contract to do this job and its superintendent was C. T. Harvey, then only 21 years old. He devised a battering ram similar to those mentioned in your March issue. This work was done in 1870 and 1871. As the job was in a remote section, Harvey utilized what local materials were available and sent men out to buy any anvils they could obtain from lumber camp blacksmith shops. The anvils thus procured were worked over to provide a sharp point at one end and socket at the other. A piece of pine timber was fitted in the socket and these implements were used to chip and chisel the rock under water, probably in a manner similar to that of the Army's chisel boat that you state was first used at Rock Island Rapids on the Mississippi in 1872.

"Harvey was a very ingenious man and he later sold the elevated railroad idea to New York City. He promoted and built the first elevated lines and continued in that field until the Tweed Ring put him out of business."

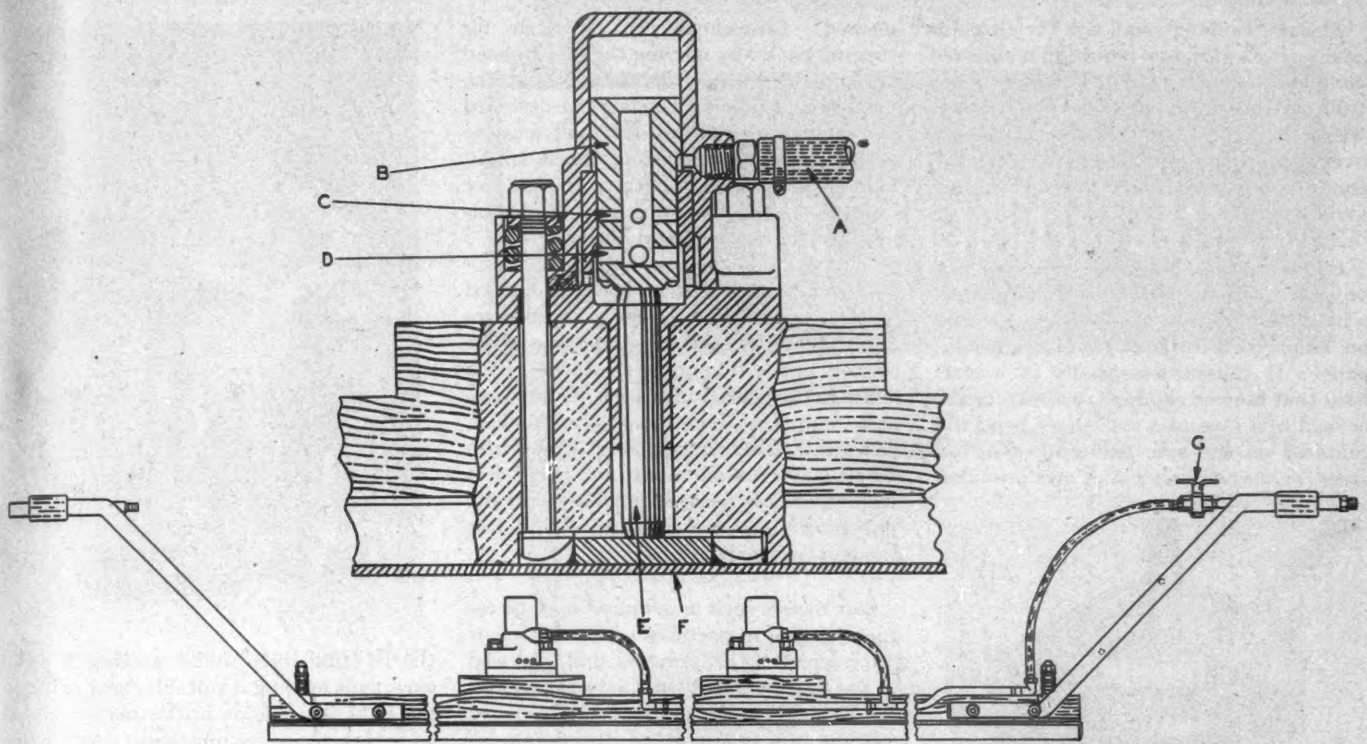
Arc-Welding Process for Repair of Castings

MAGNESIUM castings with foundry defects are being repaired by an arc-welding process that makes use of helium. It was developed by Northrop Aircraft, Inc., and is known as the Heliarc Process. The welding torch is equipped with a valve that is opened just before striking the arc and cloaks the molten metal in helium which, being an inert gas, prevents oxidation and eliminates the need of flux that would promote corrosion. In addition, it helps to dissipate heat and, by keeping weld cool, brings about better fusion and penetration with less distortion than normally.

The arc, which is struck by a light brushing action and quickly drawn back from the metal, is produced directly between the base metal and a tungsten electrode instead of between two tungsten electrodes, as is the case in atomic hydrogen welding. Electrode is slowly alloyed with the weld metal, which is usually of the same composition as the parent metal, and varies in size from 1/16 to 1/4 inch, depending upon thickness of metal and heat required. Direct-current, 150-ampere arc-welding machines are generally utilized, and torch can be used for pencil welding or, by extending handle, for heavier work.

It is claimed that almost any thickness of metal that can be cast can be welded; that welds equal in strength to surrounding metal, or even stronger, have been obtained; and that the process has been employed successfully on magnesium, brass, monel metal, stainless steel, and some carbon-steel alloys.

Pneumatic Equipment for Roadbuilder



From Compressed Air Engineering

THE COMPACTOR

Sectional view of the unit, which is used in combination with a pneumatic leveler in building concrete roads. It rests on the frame and is moved along by hand, 4 inches at a time, compacting the newly laid material by means of two valveless-type air hammers, one of which is shown in detail at the top: A– air line; B– piston; C– air parts; D– exhaust ports; E– anvil; F– anvil plate; G– air valve. Equipment compacts a 12-foot-wide strip.

AMONG the new roadbuilding equipment recently introduced abroad are a leveler, a compactor, and a finishing screed which feature pneumatic vibrators or hammers. The leveler consists of a metal plate set at an angle and is vibrated horizontally as two men wheel it along as it rests on top of the form, spreading the newly laid material and leaving an even surface for the compactor. This unit, as the accompanying line drawings show, is equipped with valveless-type air-operated hammers mounted in a wooden crossbeam and battens which, in turn, are set in a steel channel that is in direct contact with the surface of the concrete. The hammers are controlled from one of the two handles by which the compactor is manually lifted and lowered, and the air is fed through the handle to air lines that are arranged so as to keep out of the way of the concrete and the workers.

Passing down through the piston of each hammer is a hole from which radiate ports which serve as air inlets and exhausts. In the detail drawing, the piston is shown at the bottom of the stroke where it strikes an anvil which transmits the force of the impact to an anvil plate welded inside of the channel. In that position, the air above the piston is exhausted to atmosphere through the lower and larger ports, while air pressure at a point where the piston is narrower and in communication with the main air inlet lifts the piston back to the top of the cylinder. At that stage, the small-diameter ports are in line with the air inlet, compressed air passes up through the central opening, and the piston is forced down again.

The vibratory finishing screed differs from the compactor in that the pneumatic hammers are mounted on steel bridges welded to an inverted T-shaped beam which is slightly tilted so that the back edge is the screeding edge. This unit, resting on the form, is passed at a fairly rapid rate over the concrete, leaving a smooth, flat surface. The air hammers on all units are similar in design, except that the pistons in the case of the leveler just strike the anvil plates to vibrate the front plate, there is no direct transmission of the blows.

According to the manufacturer, the compactor produces a remarkably firm surface even with a water-cement ratio of .55 or .6 to 1 (by weight), a mix of this kind being easily consolidated to a depth of 12 inches. With a mix of .38 or .4 to 1, the concrete is compacted to a depth of 8 or 10 inches. The machine is moved progressively 4 inches at a time and completes a 12-foot width of roadway at the rate of 1½ to 2 square yards a minute.

New Lightweight Insulating Material

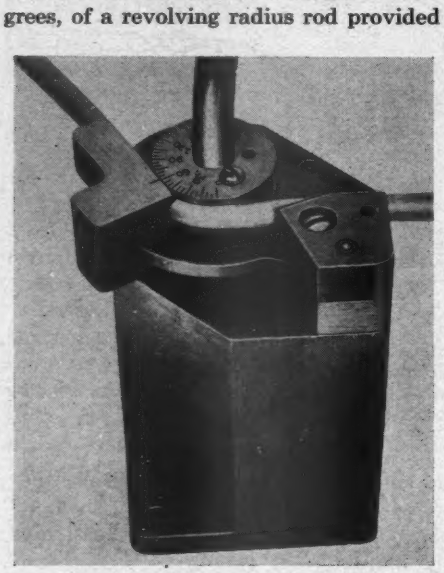
TWENTY-FIVE cents' worth of glue, says Foster D. Snell, Inc., is the basic material required to make more than a cubic foot of Foamboard, a new type of insulation recently developed by that firm of consulting chemists and engineers. The product, which weighs 1 to 3 pounds per cubic foot, is suitable for insulating railroad cars, trucks, airplanes, etc., wherever lightness and a high degree of insulation against heat, cold, or noise are essential. In thin layers, Foamboard somewhat resembles flannel, but as usually made it is more like natural sponge cut into slabs a foot or so square and an inch thick.

The materials that enter into the product are mechanically foamed in aqueous solution and then dried, becoming water insoluble and noninflammable. By a simple change in manufacture, the size of the air cells can be varied, and the foam may be compounded with synthetic rubber, asphalt, wood or glass fibers, or other substances to give the board special properties. Curing imparts high resistance to water, fungi, and other destructive agents. Additional claims made for the new product are that it can be cut with a knife, sawed, or otherwise shaped. It can be either purchased or manufactured under a license. At present, the cost of the raw materials is less than twenty cents a cubic foot.

Industrial Notes

Coaxial cable of small size for all kinds of electrical purposes requiring a shielded conductor is made by drawing fine copper tubing over insulated wire. The tubing, which may be silver plated, fits snugly over the insulation and is said to keep the conductor centered regardless of bending and forming.

Small tubes of all kinds can be given any curvature up to 360°, it is claimed, by a hand bending tool that was designed by an employee of Glenn L. Martin Company. It consists essentially of a steel base that may be clamped to a workbench or held in a vise, of a stationary bend roll centered on the base and scribed in degrees, of a revolving radius rod provided



with a handle and connected to a movable block, and of a stop block. The blocks and bend roll are grooved to prevent crushing or change in tube section. As the illustration shows, the tube is inserted in the grooves and is bent around the roll by the movable block at the left. The latter is set at zero at the start of operations, and is turned until the indicating point on top of it is in line with the degree of curvature desired. Allowance can be made for "spring back" by moving the block ahead as many degrees as the tube will spring back when released. Tool may be designed to handle tubes of any size and may be used to bend hot-dipped or tinned, spiral, high-electric cables—battery cables, for example—by substituting a set of phenol-fiber blocks for the metal blocks.

It is reported that at least 36 United States railroads are resorting to pressure grouting as a means of solidifying water pockets and soft spots in roadbeds. Rich mixtures were originally used for the purpose, but these have given way to lean mixes injected through holes driven into the ballast a few feet apart and 5 or 6 feet deep. Cost per track-foot averages $1.50. The result is a firmer roadbed and less maintenance expense.

Soft metals such as graphite may be reduced in size to particles as fine as one or two microns by a "grinding mill" devised by the International Ore Corporation and the Eagle Pencil Company. The word grinding mill as applied to the equipment is a misnomer because it has no moving parts. The material is carried through a long pipe by a current of air and is reduced by attrition as it moves along simply because that nearer the wall travels slower than that in the center of the passageway.

For the assembly of comparatively fragile materials such as canvas, plastics, insulation, etc., the Plymouth Engineering Company is offering a spinner-riveter called the Keyn Airflex. The new machine uses a relatively narrow-faced tool which comes in contact with only a part of the rivet head at each blow but which, being rotated while a pneumatic hammer strikes a succession of rapid blows, peens the entire surface. Pressure is confined to the rivet itself, is not exerted on the work. A feature of the Airflex is an adjustable spindle regulator for precise control of

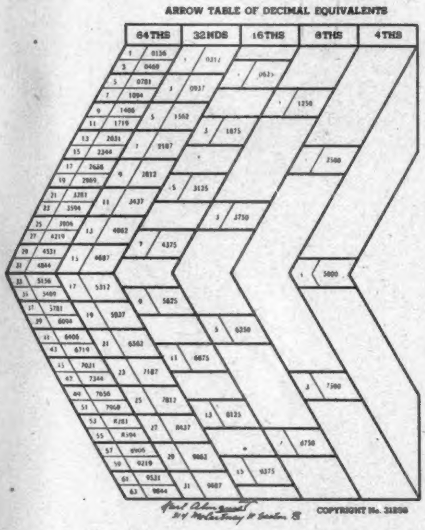
the riveting force under maximum pressure, thus making it suitable for cold heading either ductile or brittle materials. A wide range of piston sizes, used interchangeably, permits handling rivets up to ½ inch in diameter and small as well as large parts.

Like a household vacuum cleaner, the new Zoo Master Gun for automotive vehicles is provided with a variety of gadgets that enable service-station men to do just about every cleaning job on a car. There is a self-holding screw-type adapter that fits radiator hose ranging in diameter from 1 to 2 inches. With this device, and a 30-inch length of flexible hose, the gun is said to make quick work of flushing the cooling system, especially where the space around the lower radiator-hose connection is limited. By inserting an adapter extension into the heater hose the gun serves to flush the heater and the block. By substituting a nozzle for the extension and using water and compressed air the

gun becomes a pressure car washer or, by closing the water valve, a drier and blower for the removal of dirt and foreign matter lodged in the radiator fins, motor, or other parts of an automobile. The Zoo Master is a product of Kalamazoo Aero-Motive Manufacturing Company.

Jet-propulsion engines are lubricated by a mistlike spray consisting of 5 percent oil and 95 percent chilled compressed air. The lubricant is applied to ball bearings on which the single longitudinal axle of the engine revolves. The air cools the metal while the oil protects it against rust and foreign matter.

The determination of decimal equivalents has been greatly simplified by a chart devised by Karl Almquist, a mechanical designer who was associated with Ingersoll-Rand Company for many years until his recent retirement. The chart illustrated is one of several Mr. Almquist has developed for the purpose of avoiding repetition of fractions and improving legibility and is available with four decimals, as shown, and also with six.



It is made of heavy cardboard 27x24 inches in size to hang on walls of engineering departments, classrooms, shops, etc. Figures are large so they can be read easily from a distance. Smaller paper charts, 8½x11 inches, are suitable for desk use. A similar type of chart, with five decimals, gives the equivalents of fractions of an inch in millimeters. Still another combines decimal equivalents and conversions of fractions of an inch to millimeters. Further information about these helpful charts can be obtained from Karl Almquist, 434 Cattell Street, Easton, Pa.

The U. S. Bureau of Standards has developed a mechanical process for splitting mica, work that has always been done laboriously by hand. The machine consists of a disk with six chuck plates, a starter gauge, two stripper blades, and a

suction belt for the removal of the films. Although still in the experimental stage, the indications are that it will be commercially practicable.

Thimbles are usually associated with sewing. Recently, however, a modified form has appeared as an aid to assembly work. Small metal objects such as screws and nuts are generally hard to pick up and hold; but not with the new thimble, which is provided with a permanent magnet.

It is reported that wooden telephone or power poles can be tested for soundness in twenty minutes by a device developed by Homer Dana, of the engineering staff of Washington State College, in coöperation with the Washington Water Power Company of Spokane. Simply by turning a crank, the repairman screws a probe into the pole. The resistance that it encounters is recorded on a graph and determines whether the wood is sound or rotten.

Lake Chemical Company is offering a pipe-joint compound in clean, handy-to-use stick form. It is known as Pipetite-Stick and is encased in a cardboard holder so it can be carried in the pocket or tool kit ready for use. Three or four strokes of the stick across pipe-joint threads, nuts, bolts, gaskets, turnbuckles, etc., will lubricate and seal them, compound spreading and filling threads when turned. It is further claimed that Pipetite permits joints to be disconnected months after application and to be remade without the necessity of cleaning threads; does not flow into and clog even the smallest-diameter pipe; withstands temperature changes and pressure; and is resistant to gasoline, oil, acid, Freon, brine, steam, water, gas, air, etc. Stick contains no lead and no injurious ingredients, making it suitable for food and refrigeration piping.

Developed during the war for hydraulic and air systems, Oilresist—a hose with a synthetic-rubber core and cover and 2-ply, rayon-cord reinforcing—is now available for civilian use. It is mandrel-made to exact inside and outside diameters by J. N. Fauver Company and is suitable for conducting oils, greases, steam, water, air, etc., on machinery and equipment. According to the manufacturer, each rayon cord is braided under uniform tension and placed at the correct angle to secure maximum bursting pressure—25 percent more than the company's older type with cotton reinforcing. It is also said to weigh less than the latter, to have greater flexibility, and no stretch or elongation under pressure. Hose can be obtained in mill lengths, or made to order in assemblies of any desired length. Sizes range from 3/16 to 1 inch inside diameter for working pressures up to 800 pounds per square inch and maximum temperature of 235°F.